Example 4a

June 17, 2020

1 Example 4a: Dynamic nonequilibrium force field - Training of DeepCalib

Example code to train DeepCalib to determine the parameters of a Brownian particle in a dynamic nonequilibrium force field.

DeepCalib 1.0 Enhanced force-field calibration via machine learning version 1.0 - 27 April 2020
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1.1 1. INIZIALIZATION

```
In [12]: import DeepCalib
```

1.2 2. DEFINE TRAJECTORY SIMULATION

Here the function that simulates the motion of the Brownian particle in the force field under consideration is defined. Specifically, in this case, we consider a Brownian particle in a dynamic nonequilibrium force field, and the motion of the particle depends on three target parameters: the higher trap stiffness ky, the lower trap stiffness kx and the switching frequency f. This function is used to generate the pretrained network "Network_Example_4a.h5" that is going to be used in analyzing the experimental data in Examble 4b.

Comments: 1. The function that simulates the trajectories must be called simulate_trajectory. 2. Lambda functions scale_inputs, rescale_inputs, scale_targets, and rescale_targets must also be defined. For the best performance of the learning, the rescaling of both the inputs and targets should lead to values of order 1.

```
In [13]: ### Physical parameters

         from math import pi
         from scipy.constants import Boltzmann as kB

         R = 1e-7                          # Radius of the Brownian particle [m]
         eta = 0.001                       # Viscosity of the medium [kg m^-1 s^-1]
         T = 300                           # Temperature [K]
         k0 = 25                           # reference stiffness value
         f0 = 0.05                         # reference frequency value
         gamma0 = 2* 6 * pi * eta * R  # Reference friction coefficient [kg s^-1]
```

```
### Simulation parameters

N = 1000                    # Number of samples of the trajectory
Dt = 1e-1                   # Timestep
oversampling = 50           # Simulation oversampling
offset = 1000               # Number of equilibration points

### Define functions to scale and rescale inputs

scale_inputs = lambda x: x * 1e+6                    # Scales input trajectory to order
rescale_inputs = lambda scaled_x: scaled_x * 1e-6    # Rescales input trajectory to phy



### Define function to scale and rescale targets

from numpy import log10

scale_targets = lambda kx, ky, f: [log10(kx / k0),
                                   log10(ky / k0),
                                   log10( f / f0)]                                  # Scale
rescale_targets = lambda scaled_kx, scaled_ky, scaled_f: [10**scaled_kx * k0,
                                                          10**scaled_ky * k0,
                                                          10**scaled_f  * f0]    # Inver

### Define the simulate_trajectory function

def simulate_trajectory(batch_size=32,
                        T=T,
                        k0=k0,
                        f0=f0,
                        gamma0=gamma0,
                        N=N,
                        Dt=Dt,
                        oversampling=oversampling,
                        offset=offset,
                        scale_inputs=scale_inputs,
                        scale_targets=scale_targets):

    """Simulates a Brownian particle in a harmonic trap

    INPUTS:

    batch_size   : size of the batch for the specific training step
    T            : absolute temperature of the medium
    k0           : reference (normalization) value of the stiffness coefficient
    f0           : reference (normalization) value of the frequency
    gamma0       :
```

```
N            : length of the output trajectory
Dt           : time resolution of the output trajectory
oversampling : the ratio of Dt and simulation timestep
offset       : number of simulation step for initial equilibriation
scale_inputs : function to scale inputs to values of order 1
scale_targets: function to scale targets to values of order 1


OUTPUTS:

inputs       : inputs prepared in two scales (real and scaled values) that consists
targets      : targets prepared in two scales (real and scaled values) that consist


"""

import numpy as np
from scipy.constants import Boltzmann as kB
from math import pi
from math import sqrt
from numpy.random import randn as gauss
from numpy.random import rand as uniform

### Randomize trajectory parameters

kx = k0 * 10**((uniform(batch_size) - .5)*1.5)
ky = k0 * 10**((uniform(batch_size) - .5)*1.5)
f = f0 * 10**((uniform(batch_size) - .5)*1.5)
phase = uniform(batch_size)*2*np.pi

kx, ky = np.minimum(kx, ky), np.maximum(kx, ky)
kx = kx/1.5
ky = ky*1.5

gamma = gamma0 * (uniform(batch_size)*.6 + .7)

### Simulate

dt = Dt / oversampling
x = np.zeros((batch_size, N))

D = kB * T / gamma
C1 =  -(kx + ky) * 1e-9 / 2 / gamma * dt
C2 =   (ky - kx) * 1e-9 / 2 / gamma * dt

C3 = np.sqrt(2 * D * dt)

X = x[:,0]
```

```
    n = 0

    for t in range(offset):                          # Offset

        X = X + (C1 + C2*np.sign(np.sin(2*np.pi*f*t*dt+phase))) * X + C3 * gauss(batch_

    for t in range(N * oversampling):                # Simulation

        X = X + (C1 + C2*np.sign(np.sin(2*np.pi*f*t*dt+phase))) * X + C3 * gauss(batch_

        if t % oversampling == 0:
            x[:,n] = X
            n += 1

    # Normalize trajectory and targets

    inputs = DeepCalib.trajectory(
        names='x',
        values=x,
        scalings='x * 1e-6',
        scaled_values=scale_inputs(x))

    targets = DeepCalib.targets(
        names=['k_low [fN/\u03BCm]', 'k_high [fN/\u03BCm]', 'frequency [s^-1]'],
        values=np.swapaxes([kx, ky, f],0,1),
        scalings=['log10(kx/k0)', 'log10(ky/k0)', 'log10(f/f0)'],
        scaled_values=np.swapaxes(scale_targets(*[kx, ky, f]),0,1))

    return inputs, targets
```

1.3 3. CHECK TRAJECTORY SIMULATION

Checks the results of the function to simulate the trajectories by plotting some examples in rescaled units.

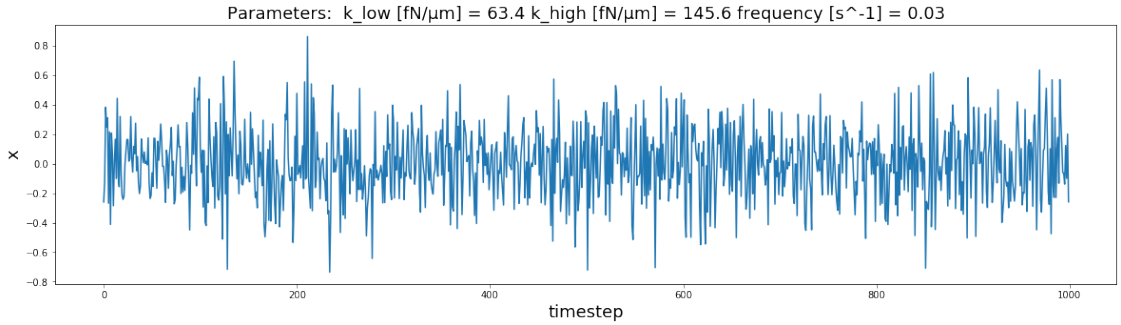
Have a look at the trajectories and check if they match your system, and keep an eye on different trajectories and make sure your scaled units vary in the order of 1, i.e, neither too small (0.01 or smaller) nor too large (100 or larger)

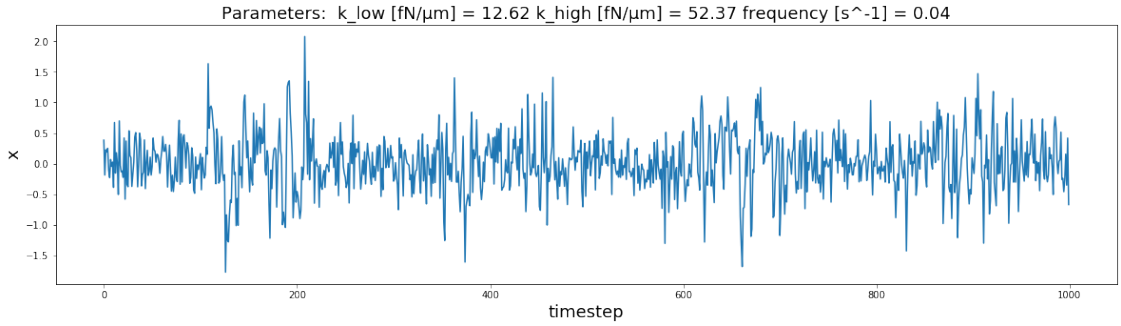
The parameter number_of_images_to_show determines the number of trajectories that are plotted.

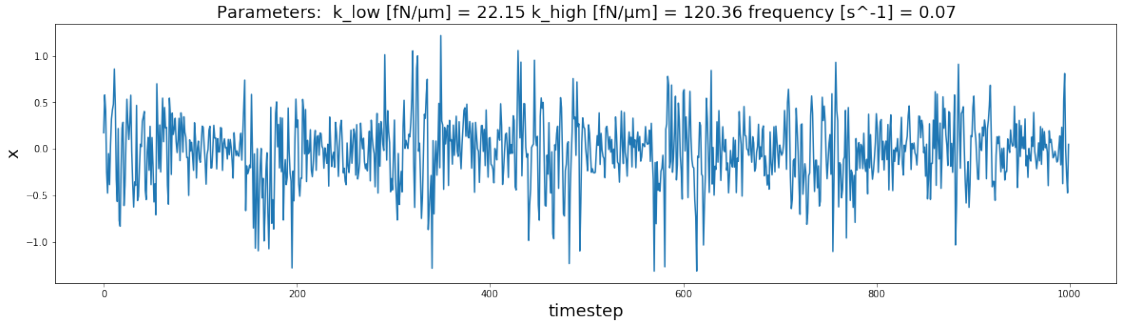
In [14]:
```
### Show some examples of simulated trajectories

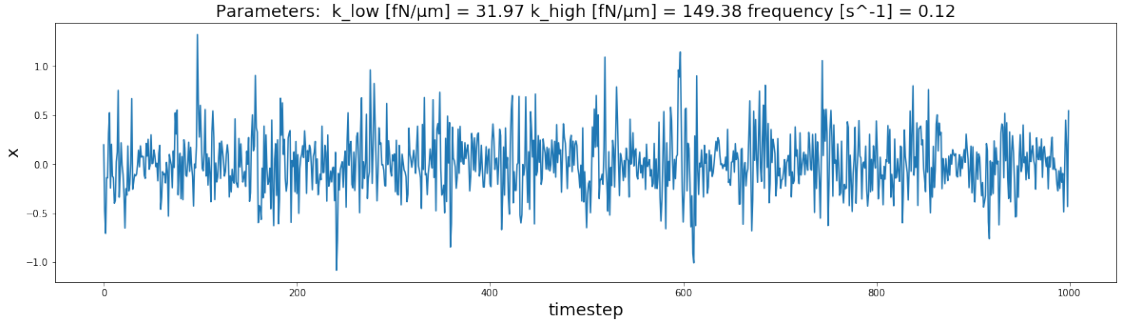
number_of_trajectories_to_show = 10

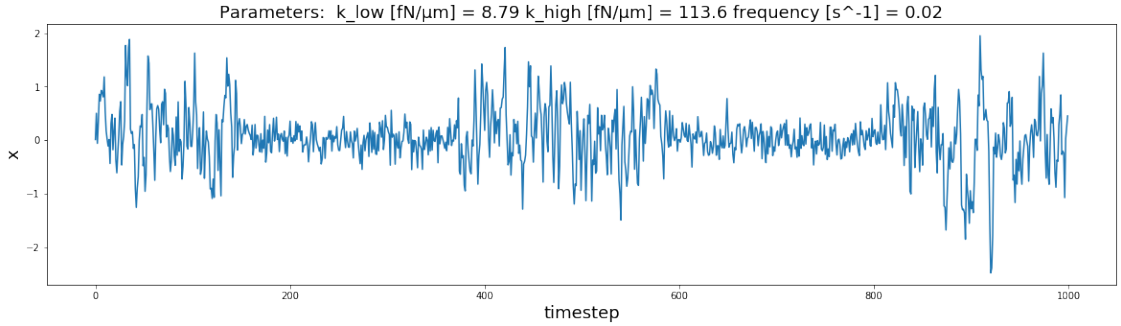
%matplotlib inline
DeepCalib.plot_sample_trajectories(simulate_trajectory, number_of_trajectories_to_show)
```

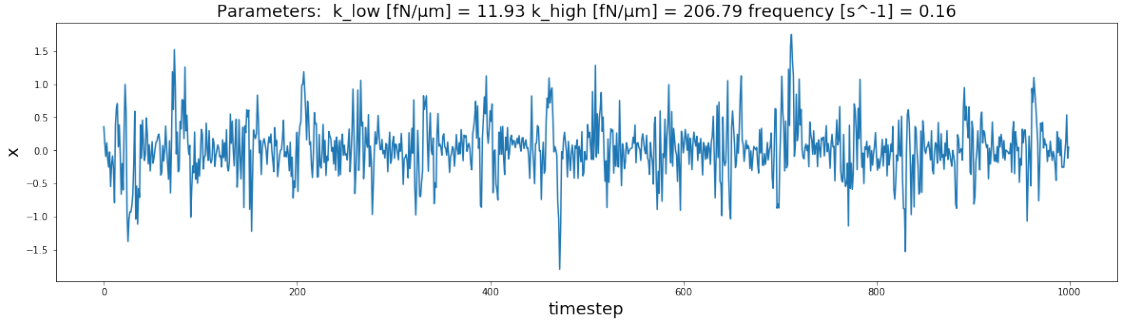

Parameters: k_low [fN/µm] = 63.4 k_high [fN/µm] = 145.6 frequency [s^-1] = 0.03
x
timestep

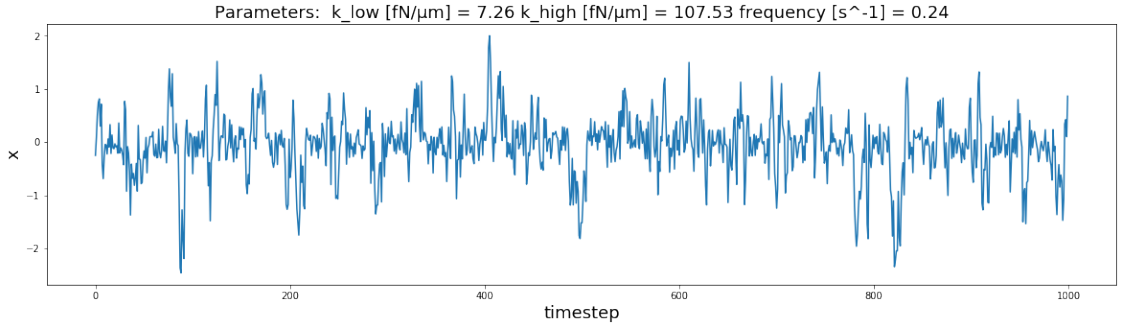

Parameters: k_low [fN/µm] = 12.62 k_high [fN/µm] = 52.37 frequency [s^-1] = 0.04
x
timestep

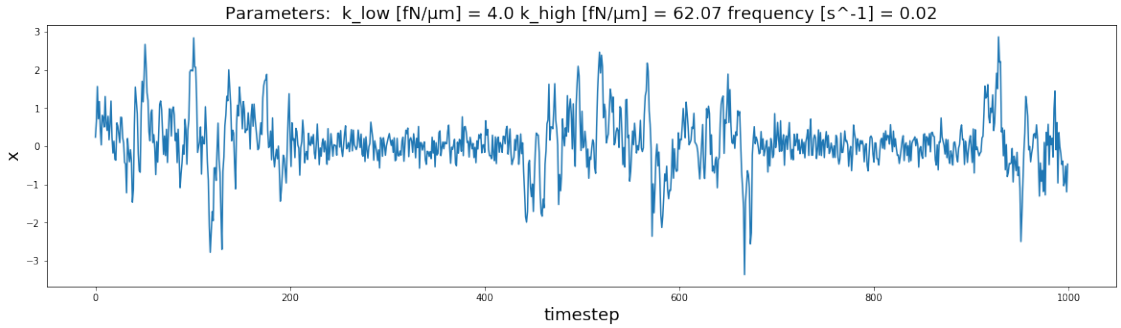

Parameters: k_low [fN/µm] = 22.15 k_high [fN/µm] = 120.36 frequency [s^-1] = 0.07
x
timestep

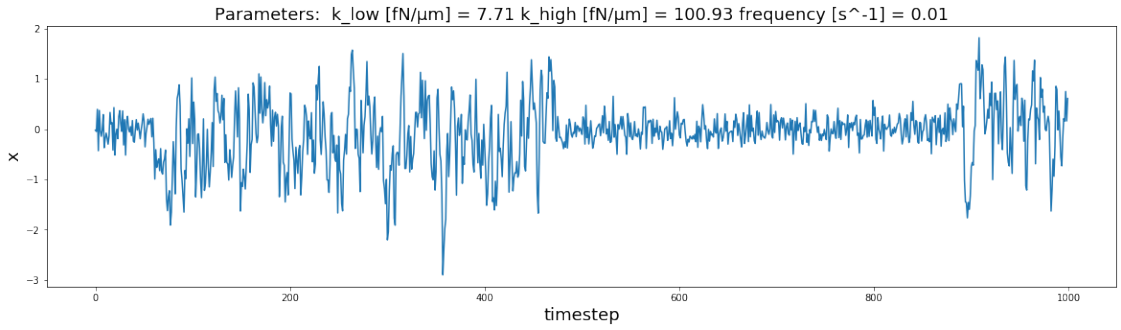

Parameters: k_low [fN/µm] = 31.97 k_high [fN/µm] = 149.38 frequency [s^-1] = 0.12
x
timestep

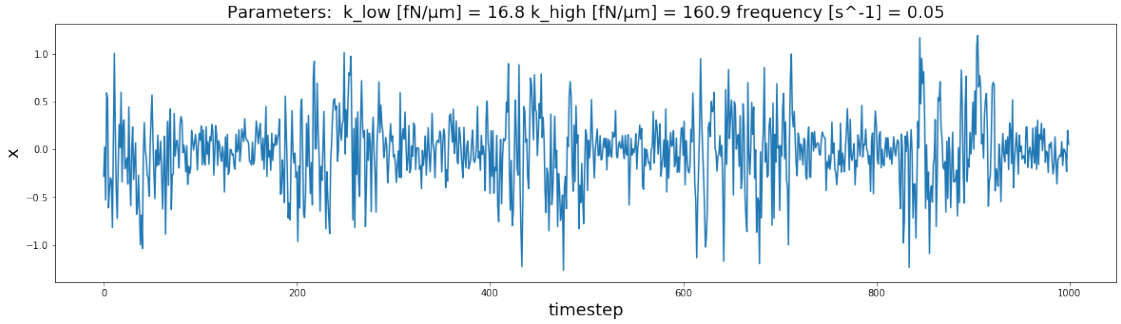

Parameters: k_low [fN/μm] = 8.79 k_high [fN/μm] = 113.6 frequency [s^-1] = 0.02
x
timestep


Parameters: k_low [fN/μm] = 11.93 k_high [fN/μm] = 206.79 frequency [s^-1] = 0.16
x
timestep


Parameters: k_low [fN/μm] = 7.26 k_high [fN/μm] = 107.53 frequency [s^-1] = 0.24
x
timestep


Parameters: k_low [fN/μm] = 4.0 k_high [fN/μm] = 62.07 frequency [s^-1] = 0.02
x
timestep





1.4 4. CREATE AND COMPILE DEEP LEARNING NETWORK

The parameters of the deep learning network are defined and the network created. The summary of the network is printed where the output shape and number of parameters for each layer can be visualized.

Comments: 1. The parameter input_shape determines the shape of the input sequence, given by the number of time-steps times the number of samples in each input sequence. Make sure your input shape dimensions match the length of the input trajectory, in this example 20 x 50 = 1000. 2. The parmameter conv_layers_dimensions determines the number and size of LSTM layers. 3. The parameter number_of_outputs determines the number of outputs, i.e. the number of force field parameters to be estimated.

```
In [15]: ### Define parameters of the deep learning network
         input_shape = (20, 50)
         lstm_layers_dimensions = (1000, 250, 50)
         number_of_outputs = 3

         ### Create deep learning network
         network = DeepCalib.create_deep_learning_network(input_shape, lstm_layers_dimensions, n
```

```
        ### Print deep learning network summary
        network.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
lstm_1 (LSTM)                (None, 20, 1000)          4204000
_________________________________________________________________
lstm_2 (LSTM)                (None, 20, 250)           1251000
_________________________________________________________________
lstm_3 (LSTM)                (None, 50)                60200
_________________________________________________________________
output (Dense)               (None, 3)                 153
=================================================================
Total params: 5,515,353
Trainable params: 5,515,353
Non-trainable params: 0
_________________________________________________________________
```

1.5 5. TRAIN DEEP LEARNING NETWORK

The parameters for the training of the deep learning network are defined and the network is trained. The sample size, iteration number, MSE, MAE and the time of each iteration is printed.

Comments: 1. The parameter sample_sizes determines the sizes of the batches of trajectories used in the training. 2. The parameter iteration_numbers determines the numbers of batches used in the training. 3. The parameter verbose determines the frequency of the update messages. It can be either a boolean value (True/False) or a number between 0 and 1.

In [16]:
```
### Define parameters of the training

        sample_sizes = (32, 128, 512, 2048)
        iteration_numbers = (1001, 3001, 3001, 4001)
        verbose = .1

        ### Training
        training_history = DeepCalib.train_deep_learning_network(network, simulate_trajectory,
```

```
Sample size     32   iteration number      1   MSE     0.3021   MAE     0.4858   Time 5251.81603
Sample size     32   iteration number     11   MSE     0.1370   MAE     0.3171   Time 260.190010
Sample size     32   iteration number     21   MSE     0.1334   MAE     0.3009   Time 280.639172
Sample size     32   iteration number     31   MSE     0.0955   MAE     0.2451   Time 293.105841
Sample size     32   iteration number     41   MSE     0.1046   MAE     0.2450   Time 274.853706
Sample size     32   iteration number     51   MSE     0.0882   MAE     0.2331   Time 267.853975
Sample size     32   iteration number     61   MSE     0.0911   MAE     0.2285   Time 267.162085
Sample size     32   iteration number     71   MSE     0.1119   MAE     0.2616   Time 251.289368
Sample size     32   iteration number     81   MSE     0.0865   MAE     0.2372   Time 266.506910
Sample size     32   iteration number     91   MSE     0.1123   MAE     0.2487   Time 271.349430
```

```
Sample size     32   iteration number    101   MSE     0.1015   MAE     0.2450   Time 256.544113
Sample size     32   iteration number    111   MSE     0.1037   MAE     0.2451   Time 295.845985
Sample size     32   iteration number    121   MSE     0.1170   MAE     0.2764   Time 260.479927
Sample size     32   iteration number    131   MSE     0.0970   MAE     0.2351   Time 265.087128
Sample size     32   iteration number    141   MSE     0.1204   MAE     0.2663   Time 263.277769
Sample size     32   iteration number    151   MSE     0.0722   MAE     0.1991   Time 256.287336
Sample size     32   iteration number    161   MSE     0.0821   MAE     0.2102   Time 267.556429
Sample size     32   iteration number    171   MSE     0.1035   MAE     0.2385   Time 252.739906
Sample size     32   iteration number    181   MSE     0.0909   MAE     0.2295   Time 265.246868
Sample size     32   iteration number    191   MSE     0.0920   MAE     0.2293   Time 271.036148
Sample size     32   iteration number    201   MSE     0.0951   MAE     0.2257   Time 282.759905
Sample size     32   iteration number    211   MSE     0.1177   MAE     0.2586   Time 254.168987
Sample size     32   iteration number    221   MSE     0.0883   MAE     0.2212   Time 267.233133
Sample size     32   iteration number    231   MSE     0.0928   MAE     0.2275   Time 261.496067
Sample size     32   iteration number    241   MSE     0.1060   MAE     0.2496   Time 275.651693
Sample size     32   iteration number    251   MSE     0.1103   MAE     0.2570   Time 279.899120
Sample size     32   iteration number    261   MSE     0.0826   MAE     0.2122   Time 262.408495
Sample size     32   iteration number    271   MSE     0.1118   MAE     0.2539   Time 264.947176
Sample size     32   iteration number    281   MSE     0.0987   MAE     0.2356   Time 286.442280
Sample size     32   iteration number    291   MSE     0.1103   MAE     0.2576   Time 279.161930
Sample size     32   iteration number    301   MSE     0.0917   MAE     0.2318   Time 252.252340
Sample size     32   iteration number    311   MSE     0.1071   MAE     0.2542   Time 286.442041
Sample size     32   iteration number    321   MSE     0.0977   MAE     0.2341   Time 286.799192
Sample size     32   iteration number    331   MSE     0.0748   MAE     0.2183   Time 259.566307
Sample size     32   iteration number    341   MSE     0.0876   MAE     0.2210   Time 269.198895
Sample size     32   iteration number    351   MSE     0.1059   MAE     0.2308   Time 284.661770
Sample size     32   iteration number    361   MSE     0.0957   MAE     0.2325   Time 259.538651
Sample size     32   iteration number    371   MSE     0.1039   MAE     0.2484   Time 267.857790
Sample size     32   iteration number    381   MSE     0.1066   MAE     0.2456   Time 283.100605
Sample size     32   iteration number    391   MSE     0.0838   MAE     0.2203   Time 268.265486
Sample size     32   iteration number    401   MSE     0.0932   MAE     0.2277   Time 276.681423
Sample size     32   iteration number    411   MSE     0.1101   MAE     0.2589   Time 306.209803
Sample size     32   iteration number    421   MSE     0.0915   MAE     0.2276   Time 280.498266
Sample size     32   iteration number    431   MSE     0.0909   MAE     0.2214   Time 259.119272
Sample size     32   iteration number    441   MSE     0.0743   MAE     0.2081   Time 264.263868
Sample size     32   iteration number    451   MSE     0.1024   MAE     0.2405   Time 310.225487
Sample size     32   iteration number    461   MSE     0.0857   MAE     0.2202   Time 317.364693
Sample size     32   iteration number    471   MSE     0.0875   MAE     0.2150   Time 309.126854
Sample size     32   iteration number    481   MSE     0.0910   MAE     0.2230   Time 294.221878
Sample size     32   iteration number    491   MSE     0.0978   MAE     0.2375   Time 301.287889
Sample size     32   iteration number    501   MSE     0.0906   MAE     0.2207   Time 308.494091
Sample size     32   iteration number    511   MSE     0.1018   MAE     0.2442   Time 318.638325
Sample size     32   iteration number    521   MSE     0.1098   MAE     0.2401   Time 276.237726
Sample size     32   iteration number    531   MSE     0.0821   MAE     0.2208   Time 278.929234
Sample size     32   iteration number    541   MSE     0.0738   MAE     0.2025   Time 277.840614
Sample size     32   iteration number    551   MSE     0.0710   MAE     0.1978   Time 263.895512
Sample size     32   iteration number    561   MSE     0.0583   MAE     0.1970   Time 248.328209
Sample size     32   iteration number    571   MSE     0.0838   MAE     0.2121   Time 302.283049
```

```
Sample size     32   iteration number    581   MSE     0.1002   MAE     0.2215   Time 314.719677
Sample size     32   iteration number    591   MSE     0.0628   MAE     0.1766   Time 266.101837
Sample size     32   iteration number    601   MSE     0.0550   MAE     0.1709   Time 308.038950
Sample size     32   iteration number    611   MSE     0.0663   MAE     0.1839   Time 264.692068
Sample size     32   iteration number    621   MSE     0.0590   MAE     0.1818   Time 282.055140
Sample size     32   iteration number    631   MSE     0.0596   MAE     0.1853   Time 279.852629
Sample size     32   iteration number    641   MSE     0.0551   MAE     0.1787   Time 280.924320
Sample size     32   iteration number    651   MSE     0.0513   MAE     0.1759   Time 288.262367
Sample size     32   iteration number    661   MSE     0.0428   MAE     0.1542   Time 294.532776
Sample size     32   iteration number    671   MSE     0.0704   MAE     0.1935   Time 292.398214
Sample size     32   iteration number    681   MSE     0.0606   MAE     0.1778   Time 279.903173
Sample size     32   iteration number    691   MSE     0.0426   MAE     0.1541   Time 279.760122
Sample size     32   iteration number    701   MSE     0.0457   MAE     0.1459   Time 275.439262
Sample size     32   iteration number    711   MSE     0.0433   MAE     0.1504   Time 277.994156
Sample size     32   iteration number    721   MSE     0.0414   MAE     0.1496   Time 286.742687
Sample size     32   iteration number    731   MSE     0.0638   MAE     0.1735   Time 267.255545
Sample size     32   iteration number    741   MSE     0.0520   MAE     0.1671   Time 273.269653
Sample size     32   iteration number    751   MSE     0.0428   MAE     0.1507   Time 277.505875
Sample size     32   iteration number    761   MSE     0.0460   MAE     0.1491   Time 283.367157
Sample size     32   iteration number    771   MSE     0.0305   MAE     0.1265   Time 290.209293
Sample size     32   iteration number    781   MSE     0.0491   MAE     0.1561   Time 269.009590
Sample size     32   iteration number    791   MSE     0.0319   MAE     0.1315   Time 250.733852
Sample size     32   iteration number    801   MSE     0.0377   MAE     0.1371   Time 270.003080
Sample size     32   iteration number    811   MSE     0.0478   MAE     0.1593   Time 251.365900
Sample size     32   iteration number    821   MSE     0.0584   MAE     0.1708   Time 272.141933
Sample size     32   iteration number    831   MSE     0.0807   MAE     0.1890   Time 267.195702
Sample size     32   iteration number    841   MSE     0.0400   MAE     0.1511   Time 276.364565
Sample size     32   iteration number    851   MSE     0.0577   MAE     0.1618   Time 285.807371
Sample size     32   iteration number    861   MSE     0.0228   MAE     0.1121   Time 287.341595
Sample size     32   iteration number    871   MSE     0.0281   MAE     0.1174   Time 269.327879
Sample size     32   iteration number    881   MSE     0.0461   MAE     0.1496   Time 279.039621
Sample size     32   iteration number    891   MSE     0.0301   MAE     0.1209   Time 252.919912
Sample size     32   iteration number    901   MSE     0.0445   MAE     0.1443   Time 266.579151
Sample size     32   iteration number    911   MSE     0.0470   MAE     0.1418   Time 249.918938
Sample size     32   iteration number    921   MSE     0.0411   MAE     0.1447   Time 274.139166
Sample size     32   iteration number    931   MSE     0.0518   MAE     0.1491   Time 286.479473
Sample size     32   iteration number    941   MSE     0.0467   MAE     0.1474   Time 263.101816
Sample size     32   iteration number    951   MSE     0.0296   MAE     0.1275   Time 283.640623
Sample size     32   iteration number    961   MSE     0.0348   MAE     0.1337   Time 269.541025
Sample size     32   iteration number    971   MSE     0.0255   MAE     0.1150   Time 258.091688
Sample size     32   iteration number    981   MSE     0.0452   MAE     0.1448   Time 250.750542
Sample size     32   iteration number    991   MSE     0.0422   MAE     0.1285   Time 268.218756
Sample size     32   iteration number   1001   MSE     0.0368   MAE     0.1299   Time 265.968084
Sample size    128   iteration number      1   MSE     0.0351   MAE     0.1296   Time 410.408020
Sample size    128   iteration number     11   MSE     0.0331   MAE     0.1253   Time 356.378794
Sample size    128   iteration number     21   MSE     0.0295   MAE     0.1157   Time 375.039816
Sample size    128   iteration number     31   MSE     0.0283   MAE     0.1152   Time 381.677866
Sample size    128   iteration number     41   MSE     0.0297   MAE     0.1077   Time 376.147270
```

```
Sample size    128   iteration number     51   MSE     0.0299   MAE     0.1139   Time 404.015303
Sample size    128   iteration number     61   MSE     0.0262   MAE     0.1134   Time 381.520033
Sample size    128   iteration number     71   MSE     0.0224   MAE     0.1005   Time 388.265848
Sample size    128   iteration number     81   MSE     0.0225   MAE     0.1027   Time 384.793997
Sample size    128   iteration number     91   MSE     0.0291   MAE     0.1110   Time 379.540205
Sample size    128   iteration number    101   MSE     0.0205   MAE     0.0953   Time 393.935680
Sample size    128   iteration number    111   MSE     0.0236   MAE     0.1010   Time 388.458252
Sample size    128   iteration number    121   MSE     0.0242   MAE     0.1058   Time 382.325172
Sample size    128   iteration number    131   MSE     0.0226   MAE     0.1001   Time 387.452126
Sample size    128   iteration number    141   MSE     0.0225   MAE     0.0990   Time 386.154175
Sample size    128   iteration number    151   MSE     0.0248   MAE     0.0995   Time 372.329712
Sample size    128   iteration number    161   MSE     0.0227   MAE     0.0985   Time 388.727665
Sample size    128   iteration number    171   MSE     0.0222   MAE     0.0936   Time 401.004314
Sample size    128   iteration number    181   MSE     0.0249   MAE     0.0987   Time 375.857115
Sample size    128   iteration number    191   MSE     0.0217   MAE     0.0936   Time 374.654770
Sample size    128   iteration number    201   MSE     0.0243   MAE     0.1042   Time 400.641203
Sample size    128   iteration number    211   MSE     0.0235   MAE     0.0971   Time 370.826244
Sample size    128   iteration number    221   MSE     0.0254   MAE     0.1033   Time 359.268665
Sample size    128   iteration number    231   MSE     0.0215   MAE     0.0967   Time 389.957905
Sample size    128   iteration number    241   MSE     0.0267   MAE     0.1049   Time 383.763790
Sample size    128   iteration number    251   MSE     0.0229   MAE     0.0989   Time 364.927053
Sample size    128   iteration number    261   MSE     0.0191   MAE     0.0881   Time 381.130695
Sample size    128   iteration number    271   MSE     0.0198   MAE     0.0841   Time 414.395571
Sample size    128   iteration number    281   MSE     0.0151   MAE     0.0815   Time 373.426914
Sample size    128   iteration number    291   MSE     0.0237   MAE     0.0946   Time 437.768221
Sample size    128   iteration number    301   MSE     0.0143   MAE     0.0808   Time 381.966829
Sample size    128   iteration number    311   MSE     0.0202   MAE     0.0881   Time 392.231941
Sample size    128   iteration number    321   MSE     0.0205   MAE     0.0939   Time 398.274660
Sample size    128   iteration number    331   MSE     0.0191   MAE     0.0836   Time 379.159212
Sample size    128   iteration number    341   MSE     0.0160   MAE     0.0865   Time 393.601179
Sample size    128   iteration number    351   MSE     0.0239   MAE     0.1001   Time 382.663250
Sample size    128   iteration number    361   MSE     0.0181   MAE     0.0832   Time 380.347490
Sample size    128   iteration number    371   MSE     0.0199   MAE     0.0882   Time 382.282495
Sample size    128   iteration number    381   MSE     0.0146   MAE     0.0792   Time 384.940147
Sample size    128   iteration number    391   MSE     0.0147   MAE     0.0805   Time 384.546757
Sample size    128   iteration number    401   MSE     0.0128   MAE     0.0750   Time 394.698143
Sample size    128   iteration number    411   MSE     0.0168   MAE     0.0838   Time 391.263962
Sample size    128   iteration number    421   MSE     0.0162   MAE     0.0827   Time 389.344215
Sample size    128   iteration number    431   MSE     0.0156   MAE     0.0773   Time 398.642778
Sample size    128   iteration number    441   MSE     0.0173   MAE     0.0834   Time 376.461029
Sample size    128   iteration number    451   MSE     0.0233   MAE     0.0923   Time 378.494263
Sample size    128   iteration number    461   MSE     0.0177   MAE     0.0834   Time 380.982161
Sample size    128   iteration number    471   MSE     0.0184   MAE     0.0896   Time 402.850151
Sample size    128   iteration number    481   MSE     0.0206   MAE     0.0867   Time 397.115469
Sample size    128   iteration number    491   MSE     0.0125   MAE     0.0749   Time 391.252518
Sample size    128   iteration number    501   MSE     0.0126   MAE     0.0739   Time 362.612009
Sample size    128   iteration number    511   MSE     0.0154   MAE     0.0813   Time 397.435904
Sample size    128   iteration number    521   MSE     0.0171   MAE     0.0800   Time 391.021013
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Sample size    128   iteration number    531   MSE     0.0165   MAE     0.0803   Time 392.971516
Sample size    128   iteration number    541   MSE     0.0177   MAE     0.0864   Time 382.757425
Sample size    128   iteration number    551   MSE     0.0202   MAE     0.0871   Time 388.984442
Sample size    128   iteration number    561   MSE     0.0110   MAE     0.0695   Time 369.738340
Sample size    128   iteration number    571   MSE     0.0166   MAE     0.0799   Time 376.960754
Sample size    128   iteration number    581   MSE     0.0171   MAE     0.0777   Time 367.265463
Sample size    128   iteration number    591   MSE     0.0184   MAE     0.0796   Time 385.570526
Sample size    128   iteration number    601   MSE     0.0147   MAE     0.0770   Time 383.300304
Sample size    128   iteration number    611   MSE     0.0104   MAE     0.0684   Time 380.179644
Sample size    128   iteration number    621   MSE     0.0149   MAE     0.0773   Time 379.622459
Sample size    128   iteration number    631   MSE     0.0146   MAE     0.0762   Time 373.704910
Sample size    128   iteration number    641   MSE     0.0107   MAE     0.0707   Time 398.382425
Sample size    128   iteration number    651   MSE     0.0135   MAE     0.0760   Time 381.028652
Sample size    128   iteration number    661   MSE     0.0158   MAE     0.0856   Time 386.934042
Sample size    128   iteration number    671   MSE     0.0157   MAE     0.0776   Time 388.925552
Sample size    128   iteration number    681   MSE     0.0152   MAE     0.0788   Time 379.004717
Sample size    128   iteration number    691   MSE     0.0191   MAE     0.0819   Time 386.602163
Sample size    128   iteration number    701   MSE     0.0166   MAE     0.0799   Time 395.927191
Sample size    128   iteration number    711   MSE     0.0121   MAE     0.0722   Time 475.777149
Sample size    128   iteration number    721   MSE     0.0104   MAE     0.0693   Time 468.746662
Sample size    128   iteration number    731   MSE     0.0110   MAE     0.0710   Time 456.777573
Sample size    128   iteration number    741   MSE     0.0115   MAE     0.0661   Time 398.966312
Sample size    128   iteration number    751   MSE     0.0097   MAE     0.0641   Time 383.973837
Sample size    128   iteration number    761   MSE     0.0097   MAE     0.0627   Time 410.939217
Sample size    128   iteration number    771   MSE     0.0102   MAE     0.0700   Time 400.285959
Sample size    128   iteration number    781   MSE     0.0140   MAE     0.0748   Time 417.102337
Sample size    128   iteration number    791   MSE     0.0169   MAE     0.0815   Time 382.242203
Sample size    128   iteration number    801   MSE     0.0150   MAE     0.0735   Time 397.554398
Sample size    128   iteration number    811   MSE     0.0113   MAE     0.0688   Time 403.095245
Sample size    128   iteration number    821   MSE     0.0168   MAE     0.0815   Time 439.756393
Sample size    128   iteration number    831   MSE     0.0140   MAE     0.0721   Time 408.495188
Sample size    128   iteration number    841   MSE     0.0145   MAE     0.0742   Time 393.296719
Sample size    128   iteration number    851   MSE     0.0109   MAE     0.0689   Time 415.251970
Sample size    128   iteration number    861   MSE     0.0151   MAE     0.0743   Time 389.594555
Sample size    128   iteration number    871   MSE     0.0164   MAE     0.0841   Time 410.801888
Sample size    128   iteration number    881   MSE     0.0161   MAE     0.0823   Time 409.856319
Sample size    128   iteration number    891   MSE     0.0122   MAE     0.0733   Time 409.920216
Sample size    128   iteration number    901   MSE     0.0106   MAE     0.0660   Time 405.849934
Sample size    128   iteration number    911   MSE     0.0095   MAE     0.0637   Time 408.846855
Sample size    128   iteration number    921   MSE     0.0128   MAE     0.0713   Time 407.131910
Sample size    128   iteration number    931   MSE     0.0123   MAE     0.0701   Time 406.172276
Sample size    128   iteration number    941   MSE     0.0086   MAE     0.0622   Time 408.166409
Sample size    128   iteration number    951   MSE     0.0079   MAE     0.0589   Time 408.532143
Sample size    128   iteration number    961   MSE     0.0134   MAE     0.0701   Time 400.069714
Sample size    128   iteration number    971   MSE     0.0111   MAE     0.0680   Time 385.708809
Sample size    128   iteration number    981   MSE     0.0080   MAE     0.0622   Time 383.219719
Sample size    128   iteration number    991   MSE     0.0144   MAE     0.0784   Time 393.879890
Sample size    128   iteration number   1001   MSE     0.0077   MAE     0.0586   Time 407.342672
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Sample size    128   iteration number   1011   MSE     0.0103   MAE     0.0681   Time 384.839296
Sample size    128   iteration number   1021   MSE     0.0095   MAE     0.0659   Time 384.994030
Sample size    128   iteration number   1031   MSE     0.0106   MAE     0.0644   Time 472.831726
Sample size    128   iteration number   1041   MSE     0.0107   MAE     0.0685   Time 389.730215
Sample size    128   iteration number   1051   MSE     0.0100   MAE     0.0632   Time 381.968260
Sample size    128   iteration number   1061   MSE     0.0079   MAE     0.0565   Time 409.881592
Sample size    128   iteration number   1071   MSE     0.0121   MAE     0.0691   Time 390.168428
Sample size    128   iteration number   1081   MSE     0.0133   MAE     0.0656   Time 387.101650
Sample size    128   iteration number   1091   MSE     0.0108   MAE     0.0668   Time 410.560846
Sample size    128   iteration number   1101   MSE     0.0081   MAE     0.0601   Time 406.006575
Sample size    128   iteration number   1111   MSE     0.0089   MAE     0.0617   Time 406.157732
Sample size    128   iteration number   1121   MSE     0.0090   MAE     0.0640   Time 405.742645
Sample size    128   iteration number   1131   MSE     0.0085   MAE     0.0614   Time 403.728724
Sample size    128   iteration number   1141   MSE     0.0132   MAE     0.0644   Time 460.998058
Sample size    128   iteration number   1151   MSE     0.0086   MAE     0.0596   Time 417.633295
Sample size    128   iteration number   1161   MSE     0.0134   MAE     0.0729   Time 412.374735
Sample size    128   iteration number   1171   MSE     0.0127   MAE     0.0694   Time 408.959866
Sample size    128   iteration number   1181   MSE     0.0104   MAE     0.0664   Time 388.736725
Sample size    128   iteration number   1191   MSE     0.0076   MAE     0.0573   Time 412.187099
Sample size    128   iteration number   1201   MSE     0.0098   MAE     0.0653   Time 386.818409
Sample size    128   iteration number   1211   MSE     0.0097   MAE     0.0606   Time 409.037828
Sample size    128   iteration number   1221   MSE     0.0092   MAE     0.0616   Time 389.090776
Sample size    128   iteration number   1231   MSE     0.0081   MAE     0.0613   Time 408.010960
Sample size    128   iteration number   1241   MSE     0.0093   MAE     0.0599   Time 392.207146
Sample size    128   iteration number   1251   MSE     0.0107   MAE     0.0671   Time 409.784794
Sample size    128   iteration number   1261   MSE     0.0111   MAE     0.0612   Time 414.874077
Sample size    128   iteration number   1271   MSE     0.0082   MAE     0.0596   Time 416.193485
Sample size    128   iteration number   1281   MSE     0.0113   MAE     0.0686   Time 412.549257
Sample size    128   iteration number   1291   MSE     0.0065   MAE     0.0583   Time 404.195786
Sample size    128   iteration number   1301   MSE     0.0083   MAE     0.0575   Time 410.644293
Sample size    128   iteration number   1311   MSE     0.0078   MAE     0.0577   Time 411.996126
Sample size    128   iteration number   1321   MSE     0.0114   MAE     0.0649   Time 417.149067
Sample size    128   iteration number   1331   MSE     0.0106   MAE     0.0650   Time 407.841444
Sample size    128   iteration number   1341   MSE     0.0098   MAE     0.0611   Time 402.058125
Sample size    128   iteration number   1351   MSE     0.0150   MAE     0.0693   Time 405.716658
Sample size    128   iteration number   1361   MSE     0.0094   MAE     0.0671   Time 405.094862
Sample size    128   iteration number   1371   MSE     0.0143   MAE     0.0704   Time 393.982410
Sample size    128   iteration number   1381   MSE     0.0113   MAE     0.0621   Time 407.837868
Sample size    128   iteration number   1391   MSE     0.0082   MAE     0.0592   Time 406.755209
Sample size    128   iteration number   1401   MSE     0.0082   MAE     0.0582   Time 411.726475
Sample size    128   iteration number   1411   MSE     0.0097   MAE     0.0603   Time 409.735203
Sample size    128   iteration number   1421   MSE     0.0074   MAE     0.0554   Time 407.212973
Sample size    128   iteration number   1431   MSE     0.0107   MAE     0.0640   Time 410.035133
Sample size    128   iteration number   1441   MSE     0.0078   MAE     0.0581   Time 406.131268
Sample size    128   iteration number   1451   MSE     0.0126   MAE     0.0620   Time 408.355474
Sample size    128   iteration number   1461   MSE     0.0076   MAE     0.0565   Time 409.219027
Sample size    128   iteration number   1471   MSE     0.0066   MAE     0.0545   Time 405.831575
Sample size    128   iteration number   1481   MSE     0.0069   MAE     0.0520   Time 400.529146
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Sample size    128   iteration number   1491   MSE     0.0097   MAE     0.0640   Time 409.005165
Sample size    128   iteration number   1501   MSE     0.0099   MAE     0.0674   Time 392.035961
Sample size    128   iteration number   1511   MSE     0.0115   MAE     0.0646   Time 381.872892
Sample size    128   iteration number   1521   MSE     0.0068   MAE     0.0523   Time 395.141125
Sample size    128   iteration number   1531   MSE     0.0090   MAE     0.0644   Time 382.893801
Sample size    128   iteration number   1541   MSE     0.0074   MAE     0.0619   Time 397.312641
Sample size    128   iteration number   1551   MSE     0.0095   MAE     0.0633   Time 383.089304
Sample size    128   iteration number   1561   MSE     0.0066   MAE     0.0569   Time 389.300346
Sample size    128   iteration number   1571   MSE     0.0105   MAE     0.0635   Time 415.292740
Sample size    128   iteration number   1581   MSE     0.0078   MAE     0.0591   Time 391.975641
Sample size    128   iteration number   1591   MSE     0.0068   MAE     0.0570   Time 388.031721
Sample size    128   iteration number   1601   MSE     0.0104   MAE     0.0634   Time 408.524990
Sample size    128   iteration number   1611   MSE     0.0084   MAE     0.0590   Time 392.158031
Sample size    128   iteration number   1621   MSE     0.0066   MAE     0.0555   Time 410.868645
Sample size    128   iteration number   1631   MSE     0.0085   MAE     0.0646   Time 406.880379
Sample size    128   iteration number   1641   MSE     0.0066   MAE     0.0537   Time 388.388872
Sample size    128   iteration number   1651   MSE     0.0060   MAE     0.0520   Time 394.657373
Sample size    128   iteration number   1661   MSE     0.0086   MAE     0.0608   Time 391.097307
Sample size    128   iteration number   1671   MSE     0.0085   MAE     0.0613   Time 387.168646
Sample size    128   iteration number   1681   MSE     0.0090   MAE     0.0635   Time 391.718626
Sample size    128   iteration number   1691   MSE     0.0092   MAE     0.0611   Time 408.077478
Sample size    128   iteration number   1701   MSE     0.0086   MAE     0.0570   Time 391.993523
Sample size    128   iteration number   1711   MSE     0.0075   MAE     0.0587   Time 387.800217
Sample size    128   iteration number   1721   MSE     0.0100   MAE     0.0604   Time 388.841391
Sample size    128   iteration number   1731   MSE     0.0106   MAE     0.0613   Time 388.854980
Sample size    128   iteration number   1741   MSE     0.0081   MAE     0.0577   Time 393.129110
Sample size    128   iteration number   1751   MSE     0.0065   MAE     0.0532   Time 385.476828
Sample size    128   iteration number   1761   MSE     0.0082   MAE     0.0591   Time 381.223440
Sample size    128   iteration number   1771   MSE     0.0058   MAE     0.0516   Time 388.528585
Sample size    128   iteration number   1781   MSE     0.0089   MAE     0.0573   Time 396.796703
Sample size    128   iteration number   1791   MSE     0.0051   MAE     0.0486   Time 383.003235
Sample size    128   iteration number   1801   MSE     0.0071   MAE     0.0542   Time 393.708706
Sample size    128   iteration number   1811   MSE     0.0105   MAE     0.0603   Time 385.979652
Sample size    128   iteration number   1821   MSE     0.0095   MAE     0.0610   Time 386.970758
Sample size    128   iteration number   1831   MSE     0.0076   MAE     0.0561   Time 386.016130
Sample size    128   iteration number   1841   MSE     0.0063   MAE     0.0553   Time 391.037226
Sample size    128   iteration number   1851   MSE     0.0058   MAE     0.0522   Time 392.049789
Sample size    128   iteration number   1861   MSE     0.0055   MAE     0.0513   Time 386.751652
Sample size    128   iteration number   1871   MSE     0.0072   MAE     0.0571   Time 392.174244
Sample size    128   iteration number   1881   MSE     0.0064   MAE     0.0512   Time 384.176731
Sample size    128   iteration number   1891   MSE     0.0055   MAE     0.0513   Time 396.391869
Sample size    128   iteration number   1901   MSE     0.0084   MAE     0.0598   Time 387.912512
Sample size    128   iteration number   1911   MSE     0.0065   MAE     0.0558   Time 385.888100
Sample size    128   iteration number   1921   MSE     0.0060   MAE     0.0493   Time 385.971069
Sample size    128   iteration number   1931   MSE     0.0089   MAE     0.0572   Time 387.102842
Sample size    128   iteration number   1941   MSE     0.0051   MAE     0.0470   Time 390.764713
Sample size    128   iteration number   1951   MSE     0.0055   MAE     0.0506   Time 388.895750
Sample size    128   iteration number   1961   MSE     0.0064   MAE     0.0515   Time 386.101007
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Sample size    128   iteration number   1971   MSE     0.0072   MAE     0.0535   Time 390.687466
Sample size    128   iteration number   1981   MSE     0.0060   MAE     0.0557   Time 388.985872
Sample size    128   iteration number   1991   MSE     0.0059   MAE     0.0520   Time 389.966488
Sample size    128   iteration number   2001   MSE     0.0065   MAE     0.0539   Time 390.719652
Sample size    128   iteration number   2011   MSE     0.0073   MAE     0.0530   Time 390.083790
Sample size    128   iteration number   2021   MSE     0.0061   MAE     0.0525   Time 389.394760
Sample size    128   iteration number   2031   MSE     0.0096   MAE     0.0574   Time 386.514187
Sample size    128   iteration number   2041   MSE     0.0065   MAE     0.0550   Time 387.670040
Sample size    128   iteration number   2051   MSE     0.0067   MAE     0.0527   Time 416.076899
Sample size    128   iteration number   2061   MSE     0.0084   MAE     0.0571   Time 406.598091
Sample size    128   iteration number   2071   MSE     0.0094   MAE     0.0572   Time 397.982359
Sample size    128   iteration number   2081   MSE     0.0059   MAE     0.0505   Time 412.884474
Sample size    128   iteration number   2091   MSE     0.0081   MAE     0.0568   Time 408.519983
Sample size    128   iteration number   2101   MSE     0.0061   MAE     0.0530   Time 413.364410
Sample size    128   iteration number   2111   MSE     0.0085   MAE     0.0554   Time 408.997774
Sample size    128   iteration number   2121   MSE     0.0051   MAE     0.0513   Time 389.140844
Sample size    128   iteration number   2131   MSE     0.0081   MAE     0.0543   Time 413.618088
Sample size    128   iteration number   2141   MSE     0.0071   MAE     0.0541   Time 415.651321
Sample size    128   iteration number   2151   MSE     0.0100   MAE     0.0595   Time 408.329487
Sample size    128   iteration number   2161   MSE     0.0069   MAE     0.0578   Time 408.126831
Sample size    128   iteration number   2171   MSE     0.0049   MAE     0.0522   Time 386.424303
Sample size    128   iteration number   2181   MSE     0.0054   MAE     0.0507   Time 394.250631
Sample size    128   iteration number   2191   MSE     0.0063   MAE     0.0541   Time 386.263609
Sample size    128   iteration number   2201   MSE     0.0057   MAE     0.0501   Time 381.963730
Sample size    128   iteration number   2211   MSE     0.0073   MAE     0.0546   Time 414.616346
Sample size    128   iteration number   2221   MSE     0.0054   MAE     0.0515   Time 413.999081
Sample size    128   iteration number   2231   MSE     0.0078   MAE     0.0496   Time 408.643246
Sample size    128   iteration number   2241   MSE     0.0086   MAE     0.0571   Time 410.118341
Sample size    128   iteration number   2251   MSE     0.0064   MAE     0.0537   Time 410.001040
Sample size    128   iteration number   2261   MSE     0.0056   MAE     0.0505   Time 392.686605
Sample size    128   iteration number   2271   MSE     0.0065   MAE     0.0547   Time 418.620825
Sample size    128   iteration number   2281   MSE     0.0063   MAE     0.0534   Time 413.417101
Sample size    128   iteration number   2291   MSE     0.0071   MAE     0.0512   Time 415.072680
Sample size    128   iteration number   2301   MSE     0.0053   MAE     0.0513   Time 420.398235
Sample size    128   iteration number   2311   MSE     0.0073   MAE     0.0538   Time 397.290945
Sample size    128   iteration number   2321   MSE     0.0065   MAE     0.0566   Time 383.493662
Sample size    128   iteration number   2331   MSE     0.0063   MAE     0.0502   Time 383.725405
Sample size    128   iteration number   2341   MSE     0.0077   MAE     0.0515   Time 361.455917
Sample size    128   iteration number   2351   MSE     0.0043   MAE     0.0470   Time 383.630037
Sample size    128   iteration number   2361   MSE     0.0064   MAE     0.0534   Time 375.365973
Sample size    128   iteration number   2371   MSE     0.0064   MAE     0.0517   Time 386.966228
Sample size    128   iteration number   2381   MSE     0.0062   MAE     0.0531   Time 380.812883
Sample size    128   iteration number   2391   MSE     0.0080   MAE     0.0579   Time 374.677181
Sample size    128   iteration number   2401   MSE     0.0045   MAE     0.0483   Time 380.981445
Sample size    128   iteration number   2411   MSE     0.0063   MAE     0.0533   Time 374.837637
Sample size    128   iteration number   2421   MSE     0.0066   MAE     0.0518   Time 396.060228
Sample size    128   iteration number   2431   MSE     0.0050   MAE     0.0465   Time 388.921499
Sample size    128   iteration number   2441   MSE     0.0062   MAE     0.0543   Time 394.907236
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Sample size    128   iteration number   2451   MSE     0.0073   MAE     0.0522   Time 383.973837
Sample size    128   iteration number   2461   MSE     0.0055   MAE     0.0507   Time 392.975330
Sample size    128   iteration number   2471   MSE     0.0048   MAE     0.0472   Time 386.074066
Sample size    128   iteration number   2481   MSE     0.0053   MAE     0.0501   Time 377.994061
Sample size    128   iteration number   2491   MSE     0.0062   MAE     0.0565   Time 380.625010
Sample size    128   iteration number   2501   MSE     0.0062   MAE     0.0544   Time 391.952276
Sample size    128   iteration number   2511   MSE     0.0057   MAE     0.0507   Time 385.969400
Sample size    128   iteration number   2521   MSE     0.0087   MAE     0.0569   Time 376.990557
Sample size    128   iteration number   2531   MSE     0.0057   MAE     0.0538   Time 386.966467
Sample size    128   iteration number   2541   MSE     0.0056   MAE     0.0475   Time 408.331871
Sample size    128   iteration number   2551   MSE     0.0047   MAE     0.0438   Time 398.402214
Sample size    128   iteration number   2561   MSE     0.0059   MAE     0.0498   Time 379.951477
Sample size    128   iteration number   2571   MSE     0.0056   MAE     0.0473   Time 389.810085
Sample size    128   iteration number   2581   MSE     0.0046   MAE     0.0444   Time 373.998880
Sample size    128   iteration number   2591   MSE     0.0058   MAE     0.0500   Time 384.823561
Sample size    128   iteration number   2601   MSE     0.0076   MAE     0.0492   Time 378.986835
Sample size    128   iteration number   2611   MSE     0.0054   MAE     0.0492   Time 393.549919
Sample size    128   iteration number   2621   MSE     0.0059   MAE     0.0537   Time 376.032114
Sample size    128   iteration number   2631   MSE     0.0095   MAE     0.0500   Time 379.037142
Sample size    128   iteration number   2641   MSE     0.0052   MAE     0.0489   Time 384.467602
Sample size    128   iteration number   2651   MSE     0.0053   MAE     0.0487   Time 383.080959
Sample size    128   iteration number   2661   MSE     0.0066   MAE     0.0520   Time 389.892340
Sample size    128   iteration number   2671   MSE     0.0074   MAE     0.0538   Time 392.716408
Sample size    128   iteration number   2681   MSE     0.0049   MAE     0.0457   Time 389.921427
Sample size    128   iteration number   2691   MSE     0.0073   MAE     0.0518   Time 379.983664
Sample size    128   iteration number   2701   MSE     0.0039   MAE     0.0443   Time 387.824535
Sample size    128   iteration number   2711   MSE     0.0051   MAE     0.0476   Time 373.999596
Sample size    128   iteration number   2721   MSE     0.0051   MAE     0.0491   Time 382.910013
Sample size    128   iteration number   2731   MSE     0.0050   MAE     0.0472   Time 378.693342
Sample size    128   iteration number   2741   MSE     0.0043   MAE     0.0484   Time 387.976170
Sample size    128   iteration number   2751   MSE     0.0065   MAE     0.0516   Time 381.255627
Sample size    128   iteration number   2761   MSE     0.0066   MAE     0.0504   Time 385.964155
Sample size    128   iteration number   2771   MSE     0.0059   MAE     0.0491   Time 392.949343
Sample size    128   iteration number   2781   MSE     0.0054   MAE     0.0492   Time 384.331942
Sample size    128   iteration number   2791   MSE     0.0080   MAE     0.0534   Time 391.288042
Sample size    128   iteration number   2801   MSE     0.0054   MAE     0.0466   Time 378.987312
Sample size    128   iteration number   2811   MSE     0.0056   MAE     0.0484   Time 378.124952
Sample size    128   iteration number   2821   MSE     0.0043   MAE     0.0433   Time 379.984856
Sample size    128   iteration number   2831   MSE     0.0047   MAE     0.0434   Time 403.997660
Sample size    128   iteration number   2841   MSE     0.0047   MAE     0.0467   Time 379.985094
Sample size    128   iteration number   2851   MSE     0.0068   MAE     0.0532   Time 385.605335
Sample size    128   iteration number   2861   MSE     0.0057   MAE     0.0510   Time 383.627892
Sample size    128   iteration number   2871   MSE     0.0060   MAE     0.0516   Time 364.171028
Sample size    128   iteration number   2881   MSE     0.0084   MAE     0.0493   Time 364.804029
Sample size    128   iteration number   2891   MSE     0.0065   MAE     0.0483   Time 384.053946
Sample size    128   iteration number   2901   MSE     0.0055   MAE     0.0480   Time 388.324022
Sample size    128   iteration number   2911   MSE     0.0060   MAE     0.0476   Time 382.311344
Sample size    128   iteration number   2921   MSE     0.0049   MAE     0.0450   Time 388.118982
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Sample size    128   iteration number   2931   MSE     0.0048   MAE     0.0464   Time 398.965120
Sample size    128   iteration number   2941   MSE     0.0049   MAE     0.0464   Time 391.627550
Sample size    128   iteration number   2951   MSE     0.0101   MAE     0.0535   Time 384.628773
Sample size    128   iteration number   2961   MSE     0.0067   MAE     0.0496   Time 379.650831
Sample size    128   iteration number   2971   MSE     0.0046   MAE     0.0453   Time 382.944584
Sample size    128   iteration number   2981   MSE     0.0061   MAE     0.0465   Time 377.958298
Sample size    128   iteration number   2991   MSE     0.0050   MAE     0.0427   Time 386.950731
Sample size    128   iteration number   3001   MSE     0.0040   MAE     0.0457   Time 384.181738
Sample size    512   iteration number      1   MSE     0.0066   MAE     0.0492   Time 852.688789
Sample size    512   iteration number     11   MSE     0.0052   MAE     0.0471   Time 852.640867
Sample size    512   iteration number     21   MSE     0.0042   MAE     0.0427   Time 849.029779
Sample size    512   iteration number     31   MSE     0.0041   MAE     0.0427   Time 844.863653
Sample size    512   iteration number     41   MSE     0.0045   MAE     0.0432   Time 852.101088
Sample size    512   iteration number     51   MSE     0.0049   MAE     0.0419   Time 861.625910
Sample size    512   iteration number     61   MSE     0.0034   MAE     0.0401   Time 833.252430
Sample size    512   iteration number     71   MSE     0.0040   MAE     0.0431   Time 858.148098
Sample size    512   iteration number     81   MSE     0.0034   MAE     0.0394   Time 869.702339
Sample size    512   iteration number     91   MSE     0.0050   MAE     0.0420   Time 860.729933
Sample size    512   iteration number    101   MSE     0.0035   MAE     0.0404   Time 849.692583
Sample size    512   iteration number    111   MSE     0.0034   MAE     0.0389   Time 857.687235
Sample size    512   iteration number    121   MSE     0.0038   MAE     0.0397   Time 857.757807
Sample size    512   iteration number    131   MSE     0.0037   MAE     0.0411   Time 921.046495
Sample size    512   iteration number    141   MSE     0.0044   MAE     0.0407   Time 897.227764
Sample size    512   iteration number    151   MSE     0.0033   MAE     0.0401   Time 864.052534
Sample size    512   iteration number    161   MSE     0.0037   MAE     0.0408   Time 888.230085
Sample size    512   iteration number    171   MSE     0.0034   MAE     0.0397   Time 900.516033
Sample size    512   iteration number    181   MSE     0.0041   MAE     0.0396   Time 868.261576
Sample size    512   iteration number    191   MSE     0.0040   MAE     0.0411   Time 869.457006
Sample size    512   iteration number    201   MSE     0.0030   MAE     0.0375   Time 877.974033
Sample size    512   iteration number    211   MSE     0.0032   MAE     0.0383   Time 999.372244
Sample size    512   iteration number    221   MSE     0.0038   MAE     0.0407   Time 881.488562
Sample size    512   iteration number    231   MSE     0.0044   MAE     0.0412   Time 894.079447
Sample size    512   iteration number    241   MSE     0.0036   MAE     0.0405   Time 870.946407
Sample size    512   iteration number    251   MSE     0.0038   MAE     0.0409   Time 871.169806
Sample size    512   iteration number    261   MSE     0.0033   MAE     0.0390   Time 865.939856
Sample size    512   iteration number    271   MSE     0.0033   MAE     0.0387   Time 893.181562
Sample size    512   iteration number    281   MSE     0.0033   MAE     0.0390   Time 867.519379
Sample size    512   iteration number    291   MSE     0.0037   MAE     0.0383   Time 863.815546
Sample size    512   iteration number    301   MSE     0.0038   MAE     0.0402   Time 880.138874
Sample size    512   iteration number    311   MSE     0.0037   MAE     0.0391   Time 884.011984
Sample size    512   iteration number    321   MSE     0.0032   MAE     0.0382   Time 889.055490
Sample size    512   iteration number    331   MSE     0.0032   MAE     0.0382   Time 874.340057
Sample size    512   iteration number    341   MSE     0.0032   MAE     0.0377   Time 887.301445
Sample size    512   iteration number    351   MSE     0.0029   MAE     0.0381   Time 867.256880
Sample size    512   iteration number    361   MSE     0.0039   MAE     0.0394   Time 853.806257
Sample size    512   iteration number    371   MSE     0.0034   MAE     0.0387   Time 866.617918
Sample size    512   iteration number    381   MSE     0.0039   MAE     0.0386   Time 852.859497
Sample size    512   iteration number    391   MSE     0.0031   MAE     0.0373   Time 853.401423
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Sample size    512   iteration number    401   MSE     0.0033   MAE     0.0392   Time 855.881929
Sample size    512   iteration number    411   MSE     0.0043   MAE     0.0404   Time 840.654135
Sample size    512   iteration number    421   MSE     0.0034   MAE     0.0397   Time 863.578081
Sample size    512   iteration number    431   MSE     0.0033   MAE     0.0394   Time 840.659142
Sample size    512   iteration number    441   MSE     0.0034   MAE     0.0378   Time 826.186657
Sample size    512   iteration number    451   MSE     0.0029   MAE     0.0381   Time 844.455004
Sample size    512   iteration number    461   MSE     0.0030   MAE     0.0385   Time 848.897219
Sample size    512   iteration number    471   MSE     0.0034   MAE     0.0390   Time 859.308481
Sample size    512   iteration number    481   MSE     0.0031   MAE     0.0387   Time 857.937336
Sample size    512   iteration number    491   MSE     0.0039   MAE     0.0396   Time 846.980572
Sample size    512   iteration number    501   MSE     0.0035   MAE     0.0390   Time 852.772236
Sample size    512   iteration number    511   MSE     0.0033   MAE     0.0379   Time 848.275185
Sample size    512   iteration number    521   MSE     0.0033   MAE     0.0373   Time 840.950251
Sample size    512   iteration number    531   MSE     0.0035   MAE     0.0382   Time 845.541000
Sample size    512   iteration number    541   MSE     0.0027   MAE     0.0354   Time 920.666695
Sample size    512   iteration number    551   MSE     0.0029   MAE     0.0370   Time 853.483200
Sample size    512   iteration number    561   MSE     0.0031   MAE     0.0377   Time 879.467964
Sample size    512   iteration number    571   MSE     0.0031   MAE     0.0381   Time 843.730450
Sample size    512   iteration number    581   MSE     0.0033   MAE     0.0387   Time 961.807489
Sample size    512   iteration number    591   MSE     0.0035   MAE     0.0392   Time 959.681511
Sample size    512   iteration number    601   MSE     0.0038   MAE     0.0399   Time 836.337328
Sample size    512   iteration number    611   MSE     0.0033   MAE     0.0376   Time 862.971783
Sample size    512   iteration number    621   MSE     0.0035   MAE     0.0386   Time 865.654707
Sample size    512   iteration number    631   MSE     0.0038   MAE     0.0394   Time 869.442225
Sample size    512   iteration number    641   MSE     0.0036   MAE     0.0378   Time 873.660088
Sample size    512   iteration number    651   MSE     0.0031   MAE     0.0378   Time 856.772661
Sample size    512   iteration number    661   MSE     0.0046   MAE     0.0406   Time 881.684542
Sample size    512   iteration number    671   MSE     0.0030   MAE     0.0363   Time 857.272863
Sample size    512   iteration number    681   MSE     0.0037   MAE     0.0388   Time 877.620459
Sample size    512   iteration number    691   MSE     0.0035   MAE     0.0392   Time 861.308098
Sample size    512   iteration number    701   MSE     0.0041   MAE     0.0390   Time 985.730410
Sample size    512   iteration number    711   MSE     0.0030   MAE     0.0378   Time 995.457172
Sample size    512   iteration number    721   MSE     0.0032   MAE     0.0379   Time 915.776491
Sample size    512   iteration number    731   MSE     0.0028   MAE     0.0368   Time 929.916143
Sample size    512   iteration number    741   MSE     0.0033   MAE     0.0377   Time 894.626379
Sample size    512   iteration number    751   MSE     0.0030   MAE     0.0383   Time 856.954575
Sample size    512   iteration number    761   MSE     0.0031   MAE     0.0372   Time 849.410772
Sample size    512   iteration number    771   MSE     0.0036   MAE     0.0385   Time 846.614361
Sample size    512   iteration number    781   MSE     0.0033   MAE     0.0378   Time 862.729311
Sample size    512   iteration number    791   MSE     0.0028   MAE     0.0365   Time 859.328032
Sample size    512   iteration number    801   MSE     0.0029   MAE     0.0360   Time 846.705914
Sample size    512   iteration number    811   MSE     0.0029   MAE     0.0359   Time 854.057550
Sample size    512   iteration number    821   MSE     0.0033   MAE     0.0368   Time 863.719940
Sample size    512   iteration number    831   MSE     0.0030   MAE     0.0379   Time 858.736515
Sample size    512   iteration number    841   MSE     0.0032   MAE     0.0388   Time 851.720333
Sample size    512   iteration number    851   MSE     0.0033   MAE     0.0373   Time 884.804487
Sample size    512   iteration number    861   MSE     0.0043   MAE     0.0385   Time 873.474121
Sample size    512   iteration number    871   MSE     0.0031   MAE     0.0394   Time 899.304152
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Sample size    512   iteration number    881   MSE     0.0037   MAE     0.0389   Time 917.878628
Sample size    512   iteration number    891   MSE     0.0037   MAE     0.0372   Time 892.235518
Sample size    512   iteration number    901   MSE     0.0045   MAE     0.0379   Time 880.984068
Sample size    512   iteration number    911   MSE     0.0040   MAE     0.0378   Time 872.963428
Sample size    512   iteration number    921   MSE     0.0029   MAE     0.0372   Time 874.910116
Sample size    512   iteration number    931   MSE     0.0043   MAE     0.0382   Time 871.454000
Sample size    512   iteration number    941   MSE     0.0031   MAE     0.0384   Time 882.197618
Sample size    512   iteration number    951   MSE     0.0027   MAE     0.0364   Time 871.436834
Sample size    512   iteration number    961   MSE     0.0030   MAE     0.0376   Time 861.974955
Sample size    512   iteration number    971   MSE     0.0035   MAE     0.0374   Time 869.029045
Sample size    512   iteration number    981   MSE     0.0028   MAE     0.0370   Time 872.114420
Sample size    512   iteration number    991   MSE     0.0028   MAE     0.0364   Time 866.348505
Sample size    512   iteration number   1001   MSE     0.0033   MAE     0.0375   Time 866.692543
Sample size    512   iteration number   1011   MSE     0.0029   MAE     0.0372   Time 867.523670
Sample size    512   iteration number   1021   MSE     0.0033   MAE     0.0361   Time 872.356176
Sample size    512   iteration number   1031   MSE     0.0031   MAE     0.0378   Time 862.066269
Sample size    512   iteration number   1041   MSE     0.0028   MAE     0.0363   Time 871.022463
Sample size    512   iteration number   1051   MSE     0.0030   MAE     0.0355   Time 871.038198
Sample size    512   iteration number   1061   MSE     0.0044   MAE     0.0392   Time 872.532129
Sample size    512   iteration number   1071   MSE     0.0035   MAE     0.0379   Time 869.038343
Sample size    512   iteration number   1081   MSE     0.0027   MAE     0.0363   Time 874.022007
Sample size    512   iteration number   1091   MSE     0.0034   MAE     0.0380   Time 971.109629
Sample size    512   iteration number   1101   MSE     0.0026   MAE     0.0360   Time 967.619896
Sample size    512   iteration number   1111   MSE     0.0037   MAE     0.0368   Time 871.743441
Sample size    512   iteration number   1121   MSE     0.0027   MAE     0.0353   Time 963.189602
Sample size    512   iteration number   1131   MSE     0.0035   MAE     0.0373   Time 878.730059
Sample size    512   iteration number   1141   MSE     0.0037   MAE     0.0379   Time 893.154860
Sample size    512   iteration number   1151   MSE     0.0024   MAE     0.0350   Time 868.184328
Sample size    512   iteration number   1161   MSE     0.0031   MAE     0.0366   Time 867.124081
Sample size    512   iteration number   1171   MSE     0.0027   MAE     0.0352   Time 869.950771
Sample size    512   iteration number   1181   MSE     0.0029   MAE     0.0377   Time 875.278234
Sample size    512   iteration number   1191   MSE     0.0030   MAE     0.0359   Time 870.357990
Sample size    512   iteration number   1201   MSE     0.0028   MAE     0.0355   Time 861.504555
Sample size    512   iteration number   1211   MSE     0.0028   MAE     0.0363   Time 868.213177
Sample size    512   iteration number   1221   MSE     0.0025   MAE     0.0348   Time 866.415262
Sample size    512   iteration number   1231   MSE     0.0033   MAE     0.0369   Time 871.088982
Sample size    512   iteration number   1241   MSE     0.0030   MAE     0.0371   Time 867.492437
Sample size    512   iteration number   1251   MSE     0.0034   MAE     0.0365   Time 870.112419
Sample size    512   iteration number   1261   MSE     0.0028   MAE     0.0349   Time 877.411604
Sample size    512   iteration number   1271   MSE     0.0026   MAE     0.0349   Time 866.723776
Sample size    512   iteration number   1281   MSE     0.0039   MAE     0.0380   Time 868.459463
Sample size    512   iteration number   1291   MSE     0.0026   MAE     0.0340   Time 870.689631
Sample size    512   iteration number   1301   MSE     0.0028   MAE     0.0364   Time 880.638123
Sample size    512   iteration number   1311   MSE     0.0029   MAE     0.0372   Time 880.682707
Sample size    512   iteration number   1321   MSE     0.0032   MAE     0.0358   Time 869.358301
Sample size    512   iteration number   1331   MSE     0.0028   MAE     0.0364   Time 868.064880
Sample size    512   iteration number   1341   MSE     0.0031   MAE     0.0346   Time 874.127150
Sample size    512   iteration number   1351   MSE     0.0037   MAE     0.0368   Time 873.864412
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Sample size    512   iteration number   1361   MSE     0.0031   MAE     0.0369   Time 882.833958
Sample size    512   iteration number   1371   MSE     0.0029   MAE     0.0366   Time 866.367579
Sample size    512   iteration number   1381   MSE     0.0028   MAE     0.0351   Time 871.539354
Sample size    512   iteration number   1391   MSE     0.0042   MAE     0.0383   Time 859.509230
Sample size    512   iteration number   1401   MSE     0.0031   MAE     0.0362   Time 867.483854
Sample size    512   iteration number   1411   MSE     0.0032   MAE     0.0376   Time 842.741013
Sample size    512   iteration number   1421   MSE     0.0035   MAE     0.0369   Time 849.179745
Sample size    512   iteration number   1431   MSE     0.0027   MAE     0.0353   Time 845.738649
Sample size    512   iteration number   1441   MSE     0.0029   MAE     0.0353   Time 842.715025
Sample size    512   iteration number   1451   MSE     0.0027   MAE     0.0338   Time 841.369390
Sample size    512   iteration number   1461   MSE     0.0027   MAE     0.0349   Time 833.364248
Sample size    512   iteration number   1471   MSE     0.0033   MAE     0.0338   Time 832.728863
Sample size    512   iteration number   1481   MSE     0.0031   MAE     0.0360   Time 843.188524
Sample size    512   iteration number   1491   MSE     0.0028   MAE     0.0364   Time 842.780590
Sample size    512   iteration number   1501   MSE     0.0033   MAE     0.0366   Time 834.768534
Sample size    512   iteration number   1511   MSE     0.0033   MAE     0.0371   Time 847.641468
Sample size    512   iteration number   1521   MSE     0.0026   MAE     0.0356   Time 852.808952
Sample size    512   iteration number   1531   MSE     0.0032   MAE     0.0362   Time 838.249207
Sample size    512   iteration number   1541   MSE     0.0026   MAE     0.0348   Time 849.638939
Sample size    512   iteration number   1551   MSE     0.0037   MAE     0.0364   Time 847.965479
Sample size    512   iteration number   1561   MSE     0.0024   MAE     0.0342   Time 866.377592
Sample size    512   iteration number   1571   MSE     0.0032   MAE     0.0358   Time 835.730314
Sample size    512   iteration number   1581   MSE     0.0024   MAE     0.0346   Time 856.438398
Sample size    512   iteration number   1591   MSE     0.0032   MAE     0.0352   Time 838.000536
Sample size    512   iteration number   1601   MSE     0.0028   MAE     0.0351   Time 844.500780
Sample size    512   iteration number   1611   MSE     0.0043   MAE     0.0364   Time 834.742785
Sample size    512   iteration number   1621   MSE     0.0030   MAE     0.0365   Time 843.723297
Sample size    512   iteration number   1631   MSE     0.0026   MAE     0.0355   Time 858.626842
Sample size    512   iteration number   1641   MSE     0.0028   MAE     0.0358   Time 868.352175
Sample size    512   iteration number   1651   MSE     0.0027   MAE     0.0354   Time 844.299555
Sample size    512   iteration number   1661   MSE     0.0030   MAE     0.0347   Time 850.740910
Sample size    512   iteration number   1671   MSE     0.0026   MAE     0.0348   Time 857.723475
Sample size    512   iteration number   1681   MSE     0.0031   MAE     0.0358   Time 837.258577
Sample size    512   iteration number   1691   MSE     0.0035   MAE     0.0353   Time 850.723267
Sample size    512   iteration number   1701   MSE     0.0028   MAE     0.0355   Time 838.846207
Sample size    512   iteration number   1711   MSE     0.0032   MAE     0.0354   Time 838.757992
Sample size    512   iteration number   1721   MSE     0.0042   MAE     0.0372   Time 846.010685
Sample size    512   iteration number   1731   MSE     0.0026   MAE     0.0345   Time 937.493324
Sample size    512   iteration number   1741   MSE     0.0024   MAE     0.0341   Time 846.644640
Sample size    512   iteration number   1751   MSE     0.0037   MAE     0.0369   Time 841.775417
Sample size    512   iteration number   1761   MSE     0.0030   MAE     0.0344   Time 848.133802
Sample size    512   iteration number   1771   MSE     0.0040   MAE     0.0365   Time 835.517168
Sample size    512   iteration number   1781   MSE     0.0031   MAE     0.0351   Time 845.831394
Sample size    512   iteration number   1791   MSE     0.0028   MAE     0.0360   Time 856.415510
Sample size    512   iteration number   1801   MSE     0.0037   MAE     0.0393   Time 839.811802
Sample size    512   iteration number   1811   MSE     0.0028   MAE     0.0366   Time 841.752052
Sample size    512   iteration number   1821   MSE     0.0027   MAE     0.0354   Time 826.477766
Sample size    512   iteration number   1831   MSE     0.0026   MAE     0.0346   Time 855.579138
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Sample size    512   iteration number   1841   MSE     0.0029   MAE     0.0351   Time 853.776217
Sample size    512   iteration number   1851   MSE     0.0028   MAE     0.0353   Time 827.460289
Sample size    512   iteration number   1861   MSE     0.0023   MAE     0.0342   Time 833.711624
Sample size    512   iteration number   1871   MSE     0.0030   MAE     0.0344   Time 837.100983
Sample size    512   iteration number   1881   MSE     0.0032   MAE     0.0351   Time 842.841148
Sample size    512   iteration number   1891   MSE     0.0027   MAE     0.0343   Time 852.673054
Sample size    512   iteration number   1901   MSE     0.0028   MAE     0.0359   Time 839.752197
Sample size    512   iteration number   1911   MSE     0.0031   MAE     0.0359   Time 833.770037
Sample size    512   iteration number   1921   MSE     0.0025   MAE     0.0332   Time 857.562542
Sample size    512   iteration number   1931   MSE     0.0036   MAE     0.0358   Time 835.235596
Sample size    512   iteration number   1941   MSE     0.0030   MAE     0.0346   Time 842.720270
Sample size    512   iteration number   1951   MSE     0.0029   MAE     0.0352   Time 843.510389
Sample size    512   iteration number   1961   MSE     0.0031   MAE     0.0356   Time 849.760771
Sample size    512   iteration number   1971   MSE     0.0033   MAE     0.0361   Time 841.846943
Sample size    512   iteration number   1981   MSE     0.0031   MAE     0.0362   Time 832.357883
Sample size    512   iteration number   1991   MSE     0.0033   MAE     0.0354   Time 851.172924
Sample size    512   iteration number   2001   MSE     0.0034   MAE     0.0375   Time 835.546255
Sample size    512   iteration number   2011   MSE     0.0027   MAE     0.0356   Time 937.493324
Sample size    512   iteration number   2021   MSE     0.0022   MAE     0.0329   Time 842.719078
Sample size    512   iteration number   2031   MSE     0.0022   MAE     0.0327   Time 830.207109
Sample size    512   iteration number   2041   MSE     0.0032   MAE     0.0358   Time 850.175381
Sample size    512   iteration number   2051   MSE     0.0041   MAE     0.0352   Time 846.251249
Sample size    512   iteration number   2061   MSE     0.0034   MAE     0.0338   Time 855.128288
Sample size    512   iteration number   2071   MSE     0.0029   MAE     0.0346   Time 839.755535
Sample size    512   iteration number   2081   MSE     0.0024   MAE     0.0341   Time 853.034735
Sample size    512   iteration number   2091   MSE     0.0041   MAE     0.0360   Time 851.427078
Sample size    512   iteration number   2101   MSE     0.0034   MAE     0.0355   Time 830.819607
Sample size    512   iteration number   2111   MSE     0.0024   MAE     0.0334   Time 846.534729
Sample size    512   iteration number   2121   MSE     0.0029   MAE     0.0352   Time 849.381208
Sample size    512   iteration number   2131   MSE     0.0026   MAE     0.0364   Time 839.775085
Sample size    512   iteration number   2141   MSE     0.0030   MAE     0.0362   Time 844.736099
Sample size    512   iteration number   2151   MSE     0.0026   MAE     0.0340   Time 851.776600
Sample size    512   iteration number   2161   MSE     0.0033   MAE     0.0360   Time 850.021124
Sample size    512   iteration number   2171   MSE     0.0032   MAE     0.0343   Time 841.768980
Sample size    512   iteration number   2181   MSE     0.0024   MAE     0.0332   Time 840.540409
Sample size    512   iteration number   2191   MSE     0.0033   MAE     0.0338   Time 848.792315
Sample size    512   iteration number   2201   MSE     0.0022   MAE     0.0328   Time 857.524872
Sample size    512   iteration number   2211   MSE     0.0033   MAE     0.0344   Time 838.963270
Sample size    512   iteration number   2221   MSE     0.0028   MAE     0.0337   Time 848.729610
Sample size    512   iteration number   2231   MSE     0.0020   MAE     0.0321   Time 833.350897
Sample size    512   iteration number   2241   MSE     0.0039   MAE     0.0352   Time 845.913649
Sample size    512   iteration number   2251   MSE     0.0028   MAE     0.0348   Time 857.724905
Sample size    512   iteration number   2261   MSE     0.0021   MAE     0.0320   Time 851.723194
Sample size    512   iteration number   2271   MSE     0.0029   MAE     0.0349   Time 852.642775
Sample size    512   iteration number   2281   MSE     0.0023   MAE     0.0341   Time 844.779968
Sample size    512   iteration number   2291   MSE     0.0025   MAE     0.0345   Time 844.968796
Sample size    512   iteration number   2301   MSE     0.0034   MAE     0.0359   Time 844.776154
Sample size    512   iteration number   2311   MSE     0.0024   MAE     0.0344   Time 844.860554
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Sample size    512   iteration number   2321   MSE     0.0029   MAE     0.0356   Time 846.462727
Sample size    512   iteration number   2331   MSE     0.0023   MAE     0.0333   Time 838.739395
Sample size    512   iteration number   2341   MSE     0.0027   MAE     0.0346   Time 838.139534
Sample size    512   iteration number   2351   MSE     0.0030   MAE     0.0348   Time 855.991602
Sample size    512   iteration number   2361   MSE     0.0027   MAE     0.0338   Time 833.765268
Sample size    512   iteration number   2371   MSE     0.0030   MAE     0.0362   Time 831.281900
Sample size    512   iteration number   2381   MSE     0.0029   MAE     0.0363   Time 826.933861
Sample size    512   iteration number   2391   MSE     0.0036   MAE     0.0354   Time 837.219477
Sample size    512   iteration number   2401   MSE     0.0030   MAE     0.0362   Time 849.703550
Sample size    512   iteration number   2411   MSE     0.0023   MAE     0.0345   Time 837.728739
Sample size    512   iteration number   2421   MSE     0.0027   MAE     0.0338   Time 832.980633
Sample size    512   iteration number   2431   MSE     0.0030   MAE     0.0355   Time 862.948895
Sample size    512   iteration number   2441   MSE     0.0023   MAE     0.0330   Time 856.030703
Sample size    512   iteration number   2451   MSE     0.0027   MAE     0.0346   Time 848.084688
Sample size    512   iteration number   2461   MSE     0.0025   MAE     0.0339   Time 841.686964
Sample size    512   iteration number   2471   MSE     0.0031   MAE     0.0358   Time 856.557846
Sample size    512   iteration number   2481   MSE     0.0037   MAE     0.0347   Time 841.749430
Sample size    512   iteration number   2491   MSE     0.0026   MAE     0.0349   Time 846.339703
Sample size    512   iteration number   2501   MSE     0.0030   MAE     0.0352   Time 857.434988
Sample size    512   iteration number   2511   MSE     0.0024   MAE     0.0347   Time 840.749741
Sample size    512   iteration number   2521   MSE     0.0038   MAE     0.0349   Time 840.720892
Sample size    512   iteration number   2531   MSE     0.0026   MAE     0.0328   Time 840.732098
Sample size    512   iteration number   2541   MSE     0.0022   MAE     0.0329   Time 828.916073
Sample size    512   iteration number   2551   MSE     0.0028   MAE     0.0345   Time 830.255508
Sample size    512   iteration number   2561   MSE     0.0021   MAE     0.0312   Time 852.115154
Sample size    512   iteration number   2571   MSE     0.0030   MAE     0.0342   Time 854.121208
Sample size    512   iteration number   2581   MSE     0.0029   MAE     0.0335   Time 837.109566
Sample size    512   iteration number   2591   MSE     0.0026   MAE     0.0347   Time 835.797071
Sample size    512   iteration number   2601   MSE     0.0027   MAE     0.0351   Time 841.176748
Sample size    512   iteration number   2611   MSE     0.0040   MAE     0.0344   Time 853.959322
Sample size    512   iteration number   2621   MSE     0.0026   MAE     0.0326   Time 844.741583
Sample size    512   iteration number   2631   MSE     0.0025   MAE     0.0331   Time 845.708132
Sample size    512   iteration number   2641   MSE     0.0026   MAE     0.0340   Time 851.722956
Sample size    512   iteration number   2651   MSE     0.0025   MAE     0.0337   Time 852.875471
Sample size    512   iteration number   2661   MSE     0.0028   MAE     0.0355   Time 835.874796
Sample size    512   iteration number   2671   MSE     0.0025   MAE     0.0344   Time 872.464180
Sample size    512   iteration number   2681   MSE     0.0027   MAE     0.0340   Time 877.324343
Sample size    512   iteration number   2691   MSE     0.0021   MAE     0.0319   Time 925.610542
Sample size    512   iteration number   2701   MSE     0.0043   MAE     0.0366   Time 857.576609
Sample size    512   iteration number   2711   MSE     0.0028   MAE     0.0338   Time 854.081631
Sample size    512   iteration number   2721   MSE     0.0030   MAE     0.0346   Time 843.064547
Sample size    512   iteration number   2731   MSE     0.0022   MAE     0.0328   Time 851.211309
Sample size    512   iteration number   2741   MSE     0.0021   MAE     0.0321   Time 934.167385
Sample size    512   iteration number   2751   MSE     0.0023   MAE     0.0316   Time 853.082180
Sample size    512   iteration number   2761   MSE     0.0026   MAE     0.0333   Time 836.331129
Sample size    512   iteration number   2771   MSE     0.0027   MAE     0.0338   Time 849.612236
Sample size    512   iteration number   2781   MSE     0.0033   MAE     0.0338   Time 849.118471
Sample size    512   iteration number   2791   MSE     0.0026   MAE     0.0342   Time 842.745066
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Sample size    512   iteration number   2801   MSE     0.0030   MAE     0.0349   Time 878.104687
Sample size    512   iteration number   2811   MSE     0.0029   MAE     0.0344   Time 854.280710
Sample size    512   iteration number   2821   MSE     0.0028   MAE     0.0349   Time 853.957653
Sample size    512   iteration number   2831   MSE     0.0024   MAE     0.0338   Time 905.726194
Sample size    512   iteration number   2841   MSE     0.0023   MAE     0.0328   Time 936.604261
Sample size    512   iteration number   2851   MSE     0.0021   MAE     0.0314   Time 872.716904
Sample size    512   iteration number   2861   MSE     0.0023   MAE     0.0332   Time 830.436230
Sample size    512   iteration number   2871   MSE     0.0022   MAE     0.0327   Time 854.346275
Sample size    512   iteration number   2881   MSE     0.0022   MAE     0.0331   Time 854.713678
Sample size    512   iteration number   2891   MSE     0.0026   MAE     0.0325   Time 837.297201
Sample size    512   iteration number   2901   MSE     0.0026   MAE     0.0332   Time 844.373465
Sample size    512   iteration number   2911   MSE     0.0026   MAE     0.0340   Time 867.412090
Sample size    512   iteration number   2921   MSE     0.0021   MAE     0.0323   Time 861.974239
Sample size    512   iteration number   2931   MSE     0.0023   MAE     0.0326   Time 838.641167
Sample size    512   iteration number   2941   MSE     0.0026   MAE     0.0331   Time 852.629423
Sample size    512   iteration number   2951   MSE     0.0029   MAE     0.0338   Time 845.761538
Sample size    512   iteration number   2961   MSE     0.0028   MAE     0.0344   Time 855.457067
Sample size    512   iteration number   2971   MSE     0.0024   MAE     0.0327   Time 846.895695
Sample size    512   iteration number   2981   MSE     0.0026   MAE     0.0341   Time 845.008135
Sample size    512   iteration number   2991   MSE     0.0023   MAE     0.0324   Time 847.686052
Sample size    512   iteration number   3001   MSE     0.0025   MAE     0.0337   Time 835.662127
Sample size   2048   iteration number      1   MSE     0.0027   MAE     0.0330   Time 2586.90142
Sample size   2048   iteration number     11   MSE     0.0023   MAE     0.0327   Time 2575.09136
Sample size   2048   iteration number     21   MSE     0.0024   MAE     0.0318   Time 2564.29052
Sample size   2048   iteration number     31   MSE     0.0022   MAE     0.0312   Time 2564.24117
Sample size   2048   iteration number     41   MSE     0.0022   MAE     0.0311   Time 2576.11298
Sample size   2048   iteration number     51   MSE     0.0022   MAE     0.0310   Time 2562.92676
Sample size   2048   iteration number     61   MSE     0.0021   MAE     0.0307   Time 2606.49204
Sample size   2048   iteration number     71   MSE     0.0024   MAE     0.0311   Time 2568.48359
Sample size   2048   iteration number     81   MSE     0.0020   MAE     0.0305   Time 2557.77072
Sample size   2048   iteration number     91   MSE     0.0021   MAE     0.0307   Time 2565.65165
Sample size   2048   iteration number    101   MSE     0.0020   MAE     0.0299   Time 2635.55192
Sample size   2048   iteration number    111   MSE     0.0020   MAE     0.0299   Time 2587.65435
Sample size   2048   iteration number    121   MSE     0.0019   MAE     0.0295   Time 2561.75732
Sample size   2048   iteration number    131   MSE     0.0021   MAE     0.0303   Time 2570.79815
Sample size   2048   iteration number    141   MSE     0.0022   MAE     0.0299   Time 2578.52649
Sample size   2048   iteration number    151   MSE     0.0021   MAE     0.0302   Time 2570.96672
Sample size   2048   iteration number    161   MSE     0.0021   MAE     0.0303   Time 2570.98460
Sample size   2048   iteration number    171   MSE     0.0020   MAE     0.0303   Time 2557.16729
Sample size   2048   iteration number    181   MSE     0.0024   MAE     0.0305   Time 2585.85071
Sample size   2048   iteration number    191   MSE     0.0022   MAE     0.0307   Time 2573.82679
Sample size   2048   iteration number    201   MSE     0.0022   MAE     0.0302   Time 2578.13310
Sample size   2048   iteration number    211   MSE     0.0023   MAE     0.0309   Time 2557.91020
Sample size   2048   iteration number    221   MSE     0.0020   MAE     0.0303   Time 2549.27206
Sample size   2048   iteration number    231   MSE     0.0021   MAE     0.0305   Time 2571.39778
Sample size   2048   iteration number    241   MSE     0.0022   MAE     0.0302   Time 2584.77878
Sample size   2048   iteration number    251   MSE     0.0020   MAE     0.0301   Time 2570.98007
Sample size   2048   iteration number    261   MSE     0.0020   MAE     0.0298   Time 2577.08263
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Sample size   2048   iteration number    271   MSE     0.0019   MAE     0.0295   Time 2581.22396
Sample size   2048   iteration number    281   MSE     0.0024   MAE     0.0304   Time 2560.80079
Sample size   2048   iteration number    291   MSE     0.0021   MAE     0.0304   Time 2575.58631
Sample size   2048   iteration number    301   MSE     0.0019   MAE     0.0299   Time 2565.84072
Sample size   2048   iteration number    311   MSE     0.0023   MAE     0.0307   Time 2573.09532
Sample size   2048   iteration number    321   MSE     0.0020   MAE     0.0299   Time 2569.31734
Sample size   2048   iteration number    331   MSE     0.0019   MAE     0.0300   Time 2564.56470
Sample size   2048   iteration number    341   MSE     0.0022   MAE     0.0302   Time 2568.06302
Sample size   2048   iteration number    351   MSE     0.0022   MAE     0.0302   Time 2573.24743
Sample size   2048   iteration number    361   MSE     0.0020   MAE     0.0300   Time 2568.64190
Sample size   2048   iteration number    371   MSE     0.0020   MAE     0.0296   Time 2570.20807
Sample size   2048   iteration number    381   MSE     0.0019   MAE     0.0298   Time 2591.69721
Sample size   2048   iteration number    391   MSE     0.0020   MAE     0.0300   Time 2574.45454
Sample size   2048   iteration number    401   MSE     0.0020   MAE     0.0297   Time 2593.86396
Sample size   2048   iteration number    411   MSE     0.0022   MAE     0.0304   Time 2590.42000
Sample size   2048   iteration number    421   MSE     0.0019   MAE     0.0298   Time 2573.31228
Sample size   2048   iteration number    431   MSE     0.0022   MAE     0.0308   Time 2594.59376
Sample size   2048   iteration number    441   MSE     0.0019   MAE     0.0297   Time 2574.77235
Sample size   2048   iteration number    451   MSE     0.0019   MAE     0.0293   Time 2556.88428
Sample size   2048   iteration number    461   MSE     0.0022   MAE     0.0305   Time 2619.28105
Sample size   2048   iteration number    471   MSE     0.0023   MAE     0.0306   Time 2608.49022
Sample size   2048   iteration number    481   MSE     0.0019   MAE     0.0303   Time 2583.02140
Sample size   2048   iteration number    491   MSE     0.0020   MAE     0.0295   Time 2578.26376
Sample size   2048   iteration number    501   MSE     0.0022   MAE     0.0307   Time 2570.39547
Sample size   2048   iteration number    511   MSE     0.0023   MAE     0.0310   Time 2586.10987
Sample size   2048   iteration number    521   MSE     0.0026   MAE     0.0309   Time 2565.31524
Sample size   2048   iteration number    531   MSE     0.0023   MAE     0.0302   Time 2573.12440
Sample size   2048   iteration number    541   MSE     0.0021   MAE     0.0301   Time 2575.01030
Sample size   2048   iteration number    551   MSE     0.0019   MAE     0.0297   Time 2575.11377
Sample size   2048   iteration number    561   MSE     0.0022   MAE     0.0300   Time 2581.23588
Sample size   2048   iteration number    571   MSE     0.0025   MAE     0.0303   Time 2544.96645
Sample size   2048   iteration number    581   MSE     0.0020   MAE     0.0293   Time 2572.11685
Sample size   2048   iteration number    591   MSE     0.0027   MAE     0.0301   Time 2575.15835
Sample size   2048   iteration number    601   MSE     0.0020   MAE     0.0296   Time 2573.89211
Sample size   2048   iteration number    611   MSE     0.0020   MAE     0.0298   Time 2568.89939
Sample size   2048   iteration number    621   MSE     0.0020   MAE     0.0294   Time 2569.13757
Sample size   2048   iteration number    631   MSE     0.0023   MAE     0.0299   Time 2563.04597
Sample size   2048   iteration number    641   MSE     0.0019   MAE     0.0299   Time 2577.37088
Sample size   2048   iteration number    651   MSE     0.0020   MAE     0.0301   Time 2576.28917
Sample size   2048   iteration number    661   MSE     0.0020   MAE     0.0296   Time 2584.78260
Sample size   2048   iteration number    671   MSE     0.0019   MAE     0.0295   Time 2572.94344
Sample size   2048   iteration number    681   MSE     0.0021   MAE     0.0304   Time 2557.65533
Sample size   2048   iteration number    691   MSE     0.0021   MAE     0.0298   Time 2571.32101
Sample size   2048   iteration number    701   MSE     0.0020   MAE     0.0301   Time 2559.49211
Sample size   2048   iteration number    711   MSE     0.0019   MAE     0.0294   Time 2575.85477
Sample size   2048   iteration number    721   MSE     0.0019   MAE     0.0291   Time 2565.80734
Sample size   2048   iteration number    731   MSE     0.0021   MAE     0.0303   Time 2586.63868
Sample size   2048   iteration number    741   MSE     0.0021   MAE     0.0294   Time 2565.49096
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Sample size   2048   iteration number    751   MSE     0.0022   MAE     0.0301   Time 2576.17616
Sample size   2048   iteration number    761   MSE     0.0021   MAE     0.0302   Time 2575.33145
Sample size   2048   iteration number    771   MSE     0.0020   MAE     0.0296   Time 2571.94232
Sample size   2048   iteration number    781   MSE     0.0020   MAE     0.0293   Time 2566.17140
Sample size   2048   iteration number    791   MSE     0.0020   MAE     0.0297   Time 2573.34899
Sample size   2048   iteration number    801   MSE     0.0019   MAE     0.0297   Time 2598.11329
Sample size   2048   iteration number    811   MSE     0.0021   MAE     0.0294   Time 2594.42257
Sample size   2048   iteration number    821   MSE     0.0019   MAE     0.0294   Time 2570.12867
Sample size   2048   iteration number    831   MSE     0.0023   MAE     0.0297   Time 2565.91248
Sample size   2048   iteration number    841   MSE     0.0020   MAE     0.0288   Time 2574.91445
Sample size   2048   iteration number    851   MSE     0.0021   MAE     0.0296   Time 2572.68500
Sample size   2048   iteration number    861   MSE     0.0019   MAE     0.0292   Time 2575.70147
Sample size   2048   iteration number    871   MSE     0.0019   MAE     0.0294   Time 2576.26676
Sample size   2048   iteration number    881   MSE     0.0021   MAE     0.0296   Time 2568.99762
Sample size   2048   iteration number    891   MSE     0.0018   MAE     0.0287   Time 2575.72054
Sample size   2048   iteration number    901   MSE     0.0022   MAE     0.0298   Time 2571.29406
Sample size   2048   iteration number    911   MSE     0.0020   MAE     0.0290   Time 2575.31857
Sample size   2048   iteration number    921   MSE     0.0018   MAE     0.0287   Time 2581.45952
Sample size   2048   iteration number    931   MSE     0.0019   MAE     0.0293   Time 2579.10609
Sample size   2048   iteration number    941   MSE     0.0020   MAE     0.0298   Time 2566.05887
Sample size   2048   iteration number    951   MSE     0.0019   MAE     0.0292   Time 2594.72465
Sample size   2048   iteration number    961   MSE     0.0019   MAE     0.0292   Time 2580.46603
Sample size   2048   iteration number    971   MSE     0.0020   MAE     0.0292   Time 2575.71506
Sample size   2048   iteration number    981   MSE     0.0021   MAE     0.0297   Time 2569.46492
Sample size   2048   iteration number    991   MSE     0.0017   MAE     0.0286   Time 2630.20992
Sample size   2048   iteration number   1001   MSE     0.0023   MAE     0.0301   Time 2571.00725
Sample size   2048   iteration number   1011   MSE     0.0018   MAE     0.0291   Time 2579.82778
Sample size   2048   iteration number   1021   MSE     0.0019   MAE     0.0288   Time 2562.80565
Sample size   2048   iteration number   1031   MSE     0.0025   MAE     0.0297   Time 2586.34734
Sample size   2048   iteration number   1041   MSE     0.0023   MAE     0.0291   Time 2603.24978
Sample size   2048   iteration number   1051   MSE     0.0022   MAE     0.0295   Time 2606.78410
Sample size   2048   iteration number   1061   MSE     0.0023   MAE     0.0298   Time 2565.40608
Sample size   2048   iteration number   1071   MSE     0.0020   MAE     0.0295   Time 2580.71780
Sample size   2048   iteration number   1081   MSE     0.0020   MAE     0.0292   Time 2573.02522
Sample size   2048   iteration number   1091   MSE     0.0021   MAE     0.0293   Time 2572.25608
Sample size   2048   iteration number   1101   MSE     0.0019   MAE     0.0293   Time 2567.24929
Sample size   2048   iteration number   1111   MSE     0.0018   MAE     0.0285   Time 2577.72803
Sample size   2048   iteration number   1121   MSE     0.0020   MAE     0.0296   Time 2571.30050
Sample size   2048   iteration number   1131   MSE     0.0018   MAE     0.0286   Time 2562.31260
Sample size   2048   iteration number   1141   MSE     0.0021   MAE     0.0291   Time 2576.63512
Sample size   2048   iteration number   1151   MSE     0.0016   MAE     0.0276   Time 2639.76049
Sample size   2048   iteration number   1161   MSE     0.0020   MAE     0.0286   Time 2686.27071
Sample size   2048   iteration number   1171   MSE     0.0018   MAE     0.0289   Time 2583.49299
Sample size   2048   iteration number   1181   MSE     0.0018   MAE     0.0291   Time 2568.39013
Sample size   2048   iteration number   1191   MSE     0.0020   MAE     0.0297   Time 2564.61858
Sample size   2048   iteration number   1201   MSE     0.0021   MAE     0.0288   Time 2567.37828
Sample size   2048   iteration number   1211   MSE     0.0018   MAE     0.0287   Time 2605.48138
Sample size   2048   iteration number   1221   MSE     0.0018   MAE     0.0285   Time 2580.10101
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Sample size   2048   iteration number   1231   MSE     0.0018   MAE     0.0286   Time 2598.97923
Sample size   2048   iteration number   1241   MSE     0.0020   MAE     0.0291   Time 2573.66657
Sample size   2048   iteration number   1251   MSE     0.0018   MAE     0.0288   Time 2582.26418
Sample size   2048   iteration number   1261   MSE     0.0020   MAE     0.0288   Time 2571.23541
Sample size   2048   iteration number   1271   MSE     0.0018   MAE     0.0284   Time 2573.20570
Sample size   2048   iteration number   1281   MSE     0.0017   MAE     0.0289   Time 2581.48169
Sample size   2048   iteration number   1291   MSE     0.0018   MAE     0.0286   Time 2575.54841
Sample size   2048   iteration number   1301   MSE     0.0019   MAE     0.0282   Time 2555.26137
Sample size   2048   iteration number   1311   MSE     0.0020   MAE     0.0289   Time 2557.54804
Sample size   2048   iteration number   1321   MSE     0.0019   MAE     0.0284   Time 2564.07070
Sample size   2048   iteration number   1331   MSE     0.0021   MAE     0.0298   Time 2578.50861
Sample size   2048   iteration number   1341   MSE     0.0021   MAE     0.0291   Time 2567.87586
Sample size   2048   iteration number   1351   MSE     0.0017   MAE     0.0283   Time 2567.64435
Sample size   2048   iteration number   1361   MSE     0.0017   MAE     0.0284   Time 2570.20783
Sample size   2048   iteration number   1371   MSE     0.0019   MAE     0.0288   Time 2567.38352
Sample size   2048   iteration number   1381   MSE     0.0020   MAE     0.0292   Time 2573.14777
Sample size   2048   iteration number   1391   MSE     0.0018   MAE     0.0295   Time 2568.78829
Sample size   2048   iteration number   1401   MSE     0.0019   MAE     0.0289   Time 2584.33628
Sample size   2048   iteration number   1411   MSE     0.0019   MAE     0.0288   Time 2551.33223
Sample size   2048   iteration number   1421   MSE     0.0022   MAE     0.0298   Time 2570.07479
Sample size   2048   iteration number   1431   MSE     0.0018   MAE     0.0285   Time 2566.38026
Sample size   2048   iteration number   1441   MSE     0.0018   MAE     0.0288   Time 2578.26900
Sample size   2048   iteration number   1451   MSE     0.0020   MAE     0.0287   Time 2589.77127
Sample size   2048   iteration number   1461   MSE     0.0018   MAE     0.0282   Time 2556.16188
Sample size   2048   iteration number   1471   MSE     0.0018   MAE     0.0281   Time 2600.48699
Sample size   2048   iteration number   1481   MSE     0.0019   MAE     0.0284   Time 2576.19071
Sample size   2048   iteration number   1491   MSE     0.0019   MAE     0.0285   Time 2582.92102
Sample size   2048   iteration number   1501   MSE     0.0017   MAE     0.0287   Time 2576.23362
Sample size   2048   iteration number   1511   MSE     0.0019   MAE     0.0288   Time 2604.12716
Sample size   2048   iteration number   1521   MSE     0.0021   MAE     0.0287   Time 2585.06393
Sample size   2048   iteration number   1531   MSE     0.0018   MAE     0.0289   Time 2578.72009
Sample size   2048   iteration number   1541   MSE     0.0019   MAE     0.0282   Time 2557.11698
Sample size   2048   iteration number   1551   MSE     0.0019   MAE     0.0279   Time 2571.36368
Sample size   2048   iteration number   1561   MSE     0.0022   MAE     0.0293   Time 2574.92065
Sample size   2048   iteration number   1571   MSE     0.0019   MAE     0.0287   Time 2573.48179
Sample size   2048   iteration number   1581   MSE     0.0018   MAE     0.0282   Time 2575.15502
Sample size   2048   iteration number   1591   MSE     0.0018   MAE     0.0288   Time 2568.12524
Sample size   2048   iteration number   1601   MSE     0.0022   MAE     0.0293   Time 2584.80429
Sample size   2048   iteration number   1611   MSE     0.0019   MAE     0.0286   Time 2594.75064
Sample size   2048   iteration number   1621   MSE     0.0017   MAE     0.0280   Time 2582.64040
Sample size   2048   iteration number   1631   MSE     0.0017   MAE     0.0282   Time 2603.86443
Sample size   2048   iteration number   1641   MSE     0.0018   MAE     0.0281   Time 2590.67964
Sample size   2048   iteration number   1651   MSE     0.0020   MAE     0.0288   Time 2662.92333
Sample size   2048   iteration number   1661   MSE     0.0021   MAE     0.0286   Time 2601.46689
Sample size   2048   iteration number   1671   MSE     0.0019   MAE     0.0284   Time 2571.94328
Sample size   2048   iteration number   1681   MSE     0.0020   MAE     0.0283   Time 2564.87608
Sample size   2048   iteration number   1691   MSE     0.0019   MAE     0.0284   Time 2600.32177
Sample size   2048   iteration number   1701   MSE     0.0016   MAE     0.0274   Time 2575.39892
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Sample size   2048   iteration number   1711   MSE     0.0020   MAE     0.0286   Time 2596.72904
Sample size   2048   iteration number   1721   MSE     0.0018   MAE     0.0286   Time 2564.81456
Sample size   2048   iteration number   1731   MSE     0.0020   MAE     0.0285   Time 2576.63536
Sample size   2048   iteration number   1741   MSE     0.0020   MAE     0.0282   Time 2599.71475
Sample size   2048   iteration number   1751   MSE     0.0021   MAE     0.0293   Time 2596.15087
Sample size   2048   iteration number   1761   MSE     0.0018   MAE     0.0282   Time 2608.06155
Sample size   2048   iteration number   1771   MSE     0.0025   MAE     0.0309   Time 2570.03212
Sample size   2048   iteration number   1781   MSE     0.0021   MAE     0.0290   Time 2569.75913
Sample size   2048   iteration number   1791   MSE     0.0018   MAE     0.0287   Time 2568.76659
Sample size   2048   iteration number   1801   MSE     0.0018   MAE     0.0288   Time 2587.34130
Sample size   2048   iteration number   1811   MSE     0.0018   MAE     0.0283   Time 2574.42474
Sample size   2048   iteration number   1821   MSE     0.0019   MAE     0.0281   Time 2569.73171
Sample size   2048   iteration number   1831   MSE     0.0017   MAE     0.0290   Time 2576.38979
Sample size   2048   iteration number   1841   MSE     0.0017   MAE     0.0282   Time 2568.70675
Sample size   2048   iteration number   1851   MSE     0.0017   MAE     0.0278   Time 2577.24165
Sample size   2048   iteration number   1861   MSE     0.0018   MAE     0.0281   Time 2577.48007
Sample size   2048   iteration number   1871   MSE     0.0020   MAE     0.0281   Time 2580.21473
Sample size   2048   iteration number   1881   MSE     0.0017   MAE     0.0276   Time 2554.90684
Sample size   2048   iteration number   1891   MSE     0.0020   MAE     0.0287   Time 2555.45210
Sample size   2048   iteration number   1901   MSE     0.0017   MAE     0.0278   Time 2604.45547
Sample size   2048   iteration number   1911   MSE     0.0020   MAE     0.0283   Time 2584.78403
Sample size   2048   iteration number   1921   MSE     0.0017   MAE     0.0284   Time 2607.77783
Sample size   2048   iteration number   1931   MSE     0.0017   MAE     0.0285   Time 2589.11299
Sample size   2048   iteration number   1941   MSE     0.0019   MAE     0.0289   Time 2587.73469
Sample size   2048   iteration number   1951   MSE     0.0019   MAE     0.0282   Time 2585.47806
Sample size   2048   iteration number   1961   MSE     0.0019   MAE     0.0280   Time 2594.21563
Sample size   2048   iteration number   1971   MSE     0.0016   MAE     0.0279   Time 2570.20497
Sample size   2048   iteration number   1981   MSE     0.0017   MAE     0.0282   Time 2584.94401
Sample size   2048   iteration number   1991   MSE     0.0020   MAE     0.0290   Time 2560.37306
Sample size   2048   iteration number   2001   MSE     0.0019   MAE     0.0283   Time 2591.01986
Sample size   2048   iteration number   2011   MSE     0.0017   MAE     0.0285   Time 2583.24337
Sample size   2048   iteration number   2021   MSE     0.0018   MAE     0.0281   Time 2569.11730
Sample size   2048   iteration number   2031   MSE     0.0018   MAE     0.0288   Time 2570.12820
Sample size   2048   iteration number   2041   MSE     0.0021   MAE     0.0300   Time 2596.10867
Sample size   2048   iteration number   2051   MSE     0.0019   MAE     0.0293   Time 2568.46404
Sample size   2048   iteration number   2061   MSE     0.0018   MAE     0.0288   Time 2559.99660
Sample size   2048   iteration number   2071   MSE     0.0018   MAE     0.0284   Time 2564.88227
Sample size   2048   iteration number   2081   MSE     0.0018   MAE     0.0278   Time 2573.13180
Sample size   2048   iteration number   2091   MSE     0.0017   MAE     0.0281   Time 2575.09589
Sample size   2048   iteration number   2101   MSE     0.0019   MAE     0.0284   Time 2566.32638
Sample size   2048   iteration number   2111   MSE     0.0017   MAE     0.0277   Time 2573.35734
Sample size   2048   iteration number   2121   MSE     0.0017   MAE     0.0281   Time 2579.86426
Sample size   2048   iteration number   2131   MSE     0.0017   MAE     0.0279   Time 2570.12462
Sample size   2048   iteration number   2141   MSE     0.0019   MAE     0.0282   Time 2569.21887
Sample size   2048   iteration number   2151   MSE     0.0018   MAE     0.0285   Time 2589.66612
Sample size   2048   iteration number   2161   MSE     0.0017   MAE     0.0276   Time 2579.14590
Sample size   2048   iteration number   2171   MSE     0.0017   MAE     0.0276   Time 2572.15070
Sample size   2048   iteration number   2181   MSE     0.0016   MAE     0.0276   Time 2578.87673
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Sample size   2048   iteration number   2191   MSE     0.0017   MAE     0.0280   Time 2564.08047
Sample size   2048   iteration number   2201   MSE     0.0016   MAE     0.0275   Time 2565.31238
Sample size   2048   iteration number   2211   MSE     0.0016   MAE     0.0273   Time 2571.69652
Sample size   2048   iteration number   2221   MSE     0.0018   MAE     0.0274   Time 2570.35613
Sample size   2048   iteration number   2231   MSE     0.0019   MAE     0.0284   Time 2612.58769
Sample size   2048   iteration number   2241   MSE     0.0020   MAE     0.0288   Time 2592.22173
Sample size   2048   iteration number   2251   MSE     0.0017   MAE     0.0283   Time 2577.48532
Sample size   2048   iteration number   2261   MSE     0.0016   MAE     0.0279   Time 2575.06609
Sample size   2048   iteration number   2271   MSE     0.0016   MAE     0.0272   Time 2563.49349
Sample size   2048   iteration number   2281   MSE     0.0017   MAE     0.0279   Time 2572.51787
Sample size   2048   iteration number   2291   MSE     0.0021   MAE     0.0283   Time 2578.13334
Sample size   2048   iteration number   2301   MSE     0.0018   MAE     0.0280   Time 2569.09465
Sample size   2048   iteration number   2311   MSE     0.0016   MAE     0.0273   Time 2562.96205
Sample size   2048   iteration number   2321   MSE     0.0016   MAE     0.0272   Time 2576.63369
Sample size   2048   iteration number   2331   MSE     0.0018   MAE     0.0276   Time 2569.27275
Sample size   2048   iteration number   2341   MSE     0.0016   MAE     0.0278   Time 2569.12350
Sample size   2048   iteration number   2351   MSE     0.0018   MAE     0.0282   Time 2556.26511
Sample size   2048   iteration number   2361   MSE     0.0019   MAE     0.0281   Time 2584.36822
Sample size   2048   iteration number   2371   MSE     0.0020   MAE     0.0285   Time 2578.29284
Sample size   2048   iteration number   2381   MSE     0.0018   MAE     0.0281   Time 2568.54105
Sample size   2048   iteration number   2391   MSE     0.0022   MAE     0.0286   Time 2579.58436
Sample size   2048   iteration number   2401   MSE     0.0015   MAE     0.0273   Time 2582.23629
Sample size   2048   iteration number   2411   MSE     0.0022   MAE     0.0296   Time 2581.09188
Sample size   2048   iteration number   2421   MSE     0.0018   MAE     0.0274   Time 2580.11150
Sample size   2048   iteration number   2431   MSE     0.0018   MAE     0.0282   Time 2583.35375
Sample size   2048   iteration number   2441   MSE     0.0017   MAE     0.0285   Time 2673.27714
Sample size   2048   iteration number   2451   MSE     0.0020   MAE     0.0279   Time 2578.33528
Sample size   2048   iteration number   2461   MSE     0.0017   MAE     0.0276   Time 2563.17639
Sample size   2048   iteration number   2471   MSE     0.0019   MAE     0.0282   Time 2584.96356
Sample size   2048   iteration number   2481   MSE     0.0018   MAE     0.0280   Time 2563.78507
Sample size   2048   iteration number   2491   MSE     0.0018   MAE     0.0277   Time 2570.27554
Sample size   2048   iteration number   2501   MSE     0.0020   MAE     0.0282   Time 2573.22073
Sample size   2048   iteration number   2511   MSE     0.0019   MAE     0.0294   Time 2596.10796
Sample size   2048   iteration number   2521   MSE     0.0018   MAE     0.0288   Time 2583.06956
Sample size   2048   iteration number   2531   MSE     0.0017   MAE     0.0277   Time 2582.08823
Sample size   2048   iteration number   2541   MSE     0.0018   MAE     0.0279   Time 2565.37962
Sample size   2048   iteration number   2551   MSE     0.0020   MAE     0.0288   Time 2600.32701
Sample size   2048   iteration number   2561   MSE     0.0019   MAE     0.0282   Time 2596.85635
Sample size   2048   iteration number   2571   MSE     0.0017   MAE     0.0275   Time 2583.83536
Sample size   2048   iteration number   2581   MSE     0.0017   MAE     0.0277   Time 2570.60003
Sample size   2048   iteration number   2591   MSE     0.0018   MAE     0.0279   Time 2569.69738
Sample size   2048   iteration number   2601   MSE     0.0016   MAE     0.0275   Time 2574.31030
Sample size   2048   iteration number   2611   MSE     0.0017   MAE     0.0278   Time 2578.59706
Sample size   2048   iteration number   2621   MSE     0.0016   MAE     0.0268   Time 2565.68980
Sample size   2048   iteration number   2631   MSE     0.0018   MAE     0.0278   Time 2562.17765
Sample size   2048   iteration number   2641   MSE     0.0018   MAE     0.0279   Time 2558.72082
Sample size   2048   iteration number   2651   MSE     0.0018   MAE     0.0279   Time 2583.69278
Sample size   2048   iteration number   2661   MSE     0.0018   MAE     0.0279   Time 2577.30126
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Sample size   2048   iteration number   2671   MSE     0.0018   MAE     0.0277   Time 2595.60346
Sample size   2048   iteration number   2681   MSE     0.0019   MAE     0.0279   Time 2584.13028
Sample size   2048   iteration number   2691   MSE     0.0019   MAE     0.0279   Time 2598.64378
Sample size   2048   iteration number   2701   MSE     0.0017   MAE     0.0277   Time 2589.36238
Sample size   2048   iteration number   2711   MSE     0.0020   MAE     0.0280   Time 2589.90311
Sample size   2048   iteration number   2721   MSE     0.0017   MAE     0.0273   Time 2564.65172
Sample size   2048   iteration number   2731   MSE     0.0018   MAE     0.0279   Time 2559.99541
Sample size   2048   iteration number   2741   MSE     0.0022   MAE     0.0281   Time 2578.60016
Sample size   2048   iteration number   2751   MSE     0.0016   MAE     0.0273   Time 2580.25193
Sample size   2048   iteration number   2761   MSE     0.0017   MAE     0.0276   Time 2600.12173
Sample size   2048   iteration number   2771   MSE     0.0018   MAE     0.0278   Time 2615.95177
Sample size   2048   iteration number   2781   MSE     0.0017   MAE     0.0276   Time 2570.42503
Sample size   2048   iteration number   2791   MSE     0.0015   MAE     0.0267   Time 2568.92633
Sample size   2048   iteration number   2801   MSE     0.0015   MAE     0.0271   Time 2558.40659
Sample size   2048   iteration number   2811   MSE     0.0016   MAE     0.0268   Time 2580.34539
Sample size   2048   iteration number   2821   MSE     0.0017   MAE     0.0272   Time 2567.06810
Sample size   2048   iteration number   2831   MSE     0.0016   MAE     0.0269   Time 2573.04334
Sample size   2048   iteration number   2841   MSE     0.0016   MAE     0.0271   Time 2576.55692
Sample size   2048   iteration number   2851   MSE     0.0018   MAE     0.0274   Time 2579.49185
Sample size   2048   iteration number   2861   MSE     0.0016   MAE     0.0274   Time 2585.99305
Sample size   2048   iteration number   2871   MSE     0.0019   MAE     0.0281   Time 2569.13042
Sample size   2048   iteration number   2881   MSE     0.0015   MAE     0.0271   Time 2571.81310
Sample size   2048   iteration number   2891   MSE     0.0018   MAE     0.0275   Time 2567.28673
Sample size   2048   iteration number   2901   MSE     0.0018   MAE     0.0284   Time 2563.54260
Sample size   2048   iteration number   2911   MSE     0.0018   MAE     0.0278   Time 2572.16930
Sample size   2048   iteration number   2921   MSE     0.0016   MAE     0.0275   Time 2577.03352
Sample size   2048   iteration number   2931   MSE     0.0016   MAE     0.0272   Time 2552.35886
Sample size   2048   iteration number   2941   MSE     0.0017   MAE     0.0271   Time 2568.31455
Sample size   2048   iteration number   2951   MSE     0.0015   MAE     0.0270   Time 2549.62825
Sample size   2048   iteration number   2961   MSE     0.0017   MAE     0.0273   Time 2562.60228
Sample size   2048   iteration number   2971   MSE     0.0019   MAE     0.0283   Time 2584.39278
Sample size   2048   iteration number   2981   MSE     0.0018   MAE     0.0271   Time 2567.15250
Sample size   2048   iteration number   2991   MSE     0.0017   MAE     0.0274   Time 2558.17103
Sample size   2048   iteration number   3001   MSE     0.0019   MAE     0.0279   Time 2554.05283
Sample size   2048   iteration number   3011   MSE     0.0017   MAE     0.0270   Time 2554.61740
Sample size   2048   iteration number   3021   MSE     0.0017   MAE     0.0269   Time 2598.65260
Sample size   2048   iteration number   3031   MSE     0.0017   MAE     0.0270   Time 2579.36000
Sample size   2048   iteration number   3041   MSE     0.0016   MAE     0.0269   Time 2605.08251
Sample size   2048   iteration number   3051   MSE     0.0017   MAE     0.0274   Time 2566.64490
Sample size   2048   iteration number   3061   MSE     0.0019   MAE     0.0284   Time 2570.10316
Sample size   2048   iteration number   3071   MSE     0.0017   MAE     0.0281   Time 2575.35624
Sample size   2048   iteration number   3081   MSE     0.0019   MAE     0.0278   Time 2553.77054
Sample size   2048   iteration number   3091   MSE     0.0022   MAE     0.0275   Time 2562.22295
Sample size   2048   iteration number   3101   MSE     0.0019   MAE     0.0272   Time 2562.15143
Sample size   2048   iteration number   3111   MSE     0.0018   MAE     0.0278   Time 2576.94435
Sample size   2048   iteration number   3121   MSE     0.0017   MAE     0.0269   Time 2566.26844
Sample size   2048   iteration number   3131   MSE     0.0021   MAE     0.0274   Time 2577.85773
Sample size   2048   iteration number   3141   MSE     0.0021   MAE     0.0280   Time 2576.39193
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```
Sample size   2048   iteration number   3151   MSE     0.0017   MAE     0.0276   Time 2576.44987
Sample size   2048   iteration number   3161   MSE     0.0018   MAE     0.0278   Time 2563.39454
Sample size   2048   iteration number   3171   MSE     0.0018   MAE     0.0273   Time 2597.41354
Sample size   2048   iteration number   3181   MSE     0.0015   MAE     0.0271   Time 2571.79451
Sample size   2048   iteration number   3191   MSE     0.0018   MAE     0.0274   Time 2566.67637
Sample size   2048   iteration number   3201   MSE     0.0019   MAE     0.0274   Time 2567.79909
Sample size   2048   iteration number   3211   MSE     0.0016   MAE     0.0274   Time 2568.51220
Sample size   2048   iteration number   3221   MSE     0.0015   MAE     0.0268   Time 2560.13441
Sample size   2048   iteration number   3231   MSE     0.0021   MAE     0.0279   Time 2571.06232
Sample size   2048   iteration number   3241   MSE     0.0018   MAE     0.0274   Time 2569.78130
Sample size   2048   iteration number   3251   MSE     0.0016   MAE     0.0264   Time 2570.05024
Sample size   2048   iteration number   3261   MSE     0.0017   MAE     0.0274   Time 2572.37839
Sample size   2048   iteration number   3271   MSE     0.0017   MAE     0.0279   Time 2582.83329
Sample size   2048   iteration number   3281   MSE     0.0017   MAE     0.0276   Time 2577.23498
Sample size   2048   iteration number   3291   MSE     0.0017   MAE     0.0277   Time 2586.50016
Sample size   2048   iteration number   3301   MSE     0.0015   MAE     0.0269   Time 2574.02110
Sample size   2048   iteration number   3311   MSE     0.0015   MAE     0.0270   Time 2574.58925
Sample size   2048   iteration number   3321   MSE     0.0015   MAE     0.0271   Time 2567.13652
Sample size   2048   iteration number   3331   MSE     0.0017   MAE     0.0273   Time 2564.37659
Sample size   2048   iteration number   3341   MSE     0.0017   MAE     0.0265   Time 2591.21751
Sample size   2048   iteration number   3351   MSE     0.0016   MAE     0.0270   Time 2601.25708
Sample size   2048   iteration number   3361   MSE     0.0014   MAE     0.0262   Time 2585.01243
Sample size   2048   iteration number   3371   MSE     0.0016   MAE     0.0266   Time 2604.75134
Sample size   2048   iteration number   3381   MSE     0.0019   MAE     0.0282   Time 2602.00047
Sample size   2048   iteration number   3391   MSE     0.0017   MAE     0.0272   Time 2590.08574
Sample size   2048   iteration number   3401   MSE     0.0016   MAE     0.0265   Time 2590.18921
Sample size   2048   iteration number   3411   MSE     0.0015   MAE     0.0270   Time 2573.64106
Sample size   2048   iteration number   3421   MSE     0.0015   MAE     0.0266   Time 2565.17696
Sample size   2048   iteration number   3431   MSE     0.0015   MAE     0.0268   Time 2579.81205
Sample size   2048   iteration number   3441   MSE     0.0017   MAE     0.0273   Time 2566.30635
Sample size   2048   iteration number   3451   MSE     0.0016   MAE     0.0266   Time 2563.80605
Sample size   2048   iteration number   3461   MSE     0.0016   MAE     0.0270   Time 2579.28824
Sample size   2048   iteration number   3471   MSE     0.0015   MAE     0.0266   Time 2591.74633
Sample size   2048   iteration number   3481   MSE     0.0018   MAE     0.0273   Time 2602.37550
Sample size   2048   iteration number   3491   MSE     0.0018   MAE     0.0278   Time 2604.17318
Sample size   2048   iteration number   3501   MSE     0.0021   MAE     0.0275   Time 2604.66766
Sample size   2048   iteration number   3511   MSE     0.0017   MAE     0.0273   Time 2582.83996
Sample size   2048   iteration number   3521   MSE     0.0017   MAE     0.0273   Time 2565.96851
Sample size   2048   iteration number   3531   MSE     0.0016   MAE     0.0274   Time 2600.78764
Sample size   2048   iteration number   3541   MSE     0.0016   MAE     0.0273   Time 2584.29718
Sample size   2048   iteration number   3551   MSE     0.0015   MAE     0.0267   Time 2575.62136
Sample size   2048   iteration number   3561   MSE     0.0015   MAE     0.0269   Time 2574.52392
Sample size   2048   iteration number   3571   MSE     0.0015   MAE     0.0264   Time 2565.86933
Sample size   2048   iteration number   3581   MSE     0.0017   MAE     0.0279   Time 2563.51804
Sample size   2048   iteration number   3591   MSE     0.0019   MAE     0.0283   Time 2565.05250
Sample size   2048   iteration number   3601   MSE     0.0017   MAE     0.0276   Time 2608.12354
Sample size   2048   iteration number   3611   MSE     0.0017   MAE     0.0283   Time 2593.86491
Sample size   2048   iteration number   3621   MSE     0.0017   MAE     0.0276   Time 2578.37033
```

```
Sample size   2048   iteration number   3631   MSE     0.0016   MAE     0.0271   Time 2587.87751
Sample size   2048   iteration number   3641   MSE     0.0016   MAE     0.0271   Time 2582.11374
Sample size   2048   iteration number   3651   MSE     0.0016   MAE     0.0275   Time 2580.67870
Sample size   2048   iteration number   3661   MSE     0.0016   MAE     0.0274   Time 2558.51793
Sample size   2048   iteration number   3671   MSE     0.0018   MAE     0.0277   Time 2581.88223
Sample size   2048   iteration number   3681   MSE     0.0017   MAE     0.0273   Time 2567.15965
Sample size   2048   iteration number   3691   MSE     0.0017   MAE     0.0274   Time 2554.72159
Sample size   2048   iteration number   3701   MSE     0.0019   MAE     0.0284   Time 2578.35984
Sample size   2048   iteration number   3711   MSE     0.0016   MAE     0.0267   Time 2575.47926
Sample size   2048   iteration number   3721   MSE     0.0016   MAE     0.0268   Time 2580.54924
Sample size   2048   iteration number   3731   MSE     0.0015   MAE     0.0263   Time 2567.05880
Sample size   2048   iteration number   3741   MSE     0.0018   MAE     0.0273   Time 2559.01217
Sample size   2048   iteration number   3751   MSE     0.0015   MAE     0.0267   Time 2578.87220
Sample size   2048   iteration number   3761   MSE     0.0016   MAE     0.0266   Time 2566.87974
Sample size   2048   iteration number   3771   MSE     0.0019   MAE     0.0271   Time 2591.92776
Sample size   2048   iteration number   3781   MSE     0.0015   MAE     0.0275   Time 2600.45743
Sample size   2048   iteration number   3791   MSE     0.0022   MAE     0.0279   Time 2578.90582
Sample size   2048   iteration number   3801   MSE     0.0015   MAE     0.0266   Time 2559.14712
Sample size   2048   iteration number   3811   MSE     0.0020   MAE     0.0275   Time 2570.58286
Sample size   2048   iteration number   3821   MSE     0.0017   MAE     0.0280   Time 2583.07433
Sample size   2048   iteration number   3831   MSE     0.0017   MAE     0.0269   Time 2580.58810
Sample size   2048   iteration number   3841   MSE     0.0017   MAE     0.0272   Time 2602.68068
Sample size   2048   iteration number   3851   MSE     0.0017   MAE     0.0270   Time 2560.30368
Sample size   2048   iteration number   3861   MSE     0.0016   MAE     0.0268   Time 2564.52751
Sample size   2048   iteration number   3871   MSE     0.0020   MAE     0.0271   Time 2574.92232
Sample size   2048   iteration number   3881   MSE     0.0015   MAE     0.0268   Time 2569.14210
Sample size   2048   iteration number   3891   MSE     0.0018   MAE     0.0281   Time 2581.33602
Sample size   2048   iteration number   3901   MSE     0.0015   MAE     0.0275   Time 2576.58362
Sample size   2048   iteration number   3911   MSE     0.0020   MAE     0.0274   Time 2578.85575
Sample size   2048   iteration number   3921   MSE     0.0016   MAE     0.0268   Time 2573.11940
Sample size   2048   iteration number   3931   MSE     0.0015   MAE     0.0263   Time 2571.29526
Sample size   2048   iteration number   3941   MSE     0.0017   MAE     0.0267   Time 2573.19879
Sample size   2048   iteration number   3951   MSE     0.0015   MAE     0.0268   Time 2578.03750
Sample size   2048   iteration number   3961   MSE     0.0017   MAE     0.0265   Time 2572.11709
Sample size   2048   iteration number   3971   MSE     0.0016   MAE     0.0270   Time 2583.18638
Sample size   2048   iteration number   3981   MSE     0.0019   MAE     0.0269   Time 2582.07392
Sample size   2048   iteration number   3991   MSE     0.0017   MAE     0.0270   Time 2571.65980
Sample size   2048   iteration number   4001   MSE     0.0019   MAE     0.0278   Time 2563.45510
```

1.6 6. PLOT LEARNING PERFORMANCE

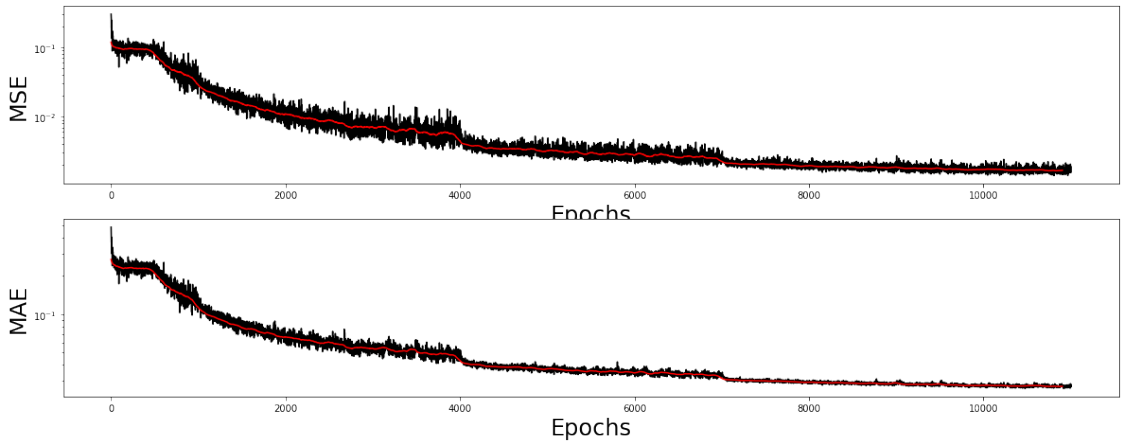
The learning performance is plotted. The MSE, MAE, sample size, iteration number and iteration time are plotted against the number of timesteps.

Comment: 1. The parameter number_of_timesteps_for_average determines the length of the average. It must be a positive integer number.

```
In [17]: ### Plot learning performance
```

```
number_of_timesteps_for_average = 100

DeepCalib.plot_learning_performance(training_history, number_of_timesteps_for_average)
```



1.7 7. TEST DEEP LEARNING NETWORK ON NEW SIMULATED TRAJECTORIES

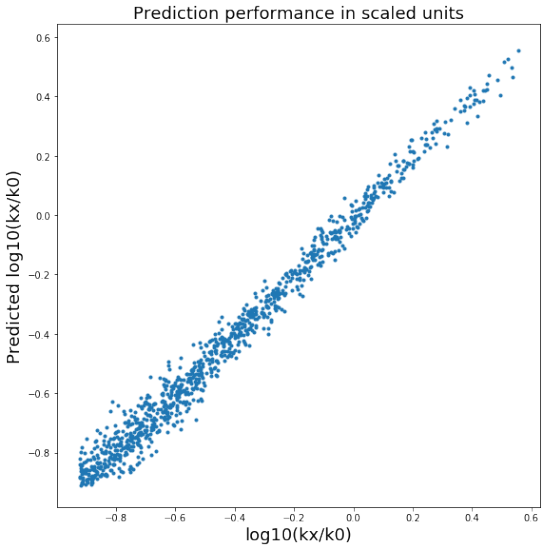
The deep learning network is tested on new simulated trajectories (parameters are defined in Section **??**). The predicted values of the targets are plotted as function of their ground-truth values both in scaled and physical units.

Comments: 1. The parameter number_of_predictions_to_show determines the number of predictions that are shown.

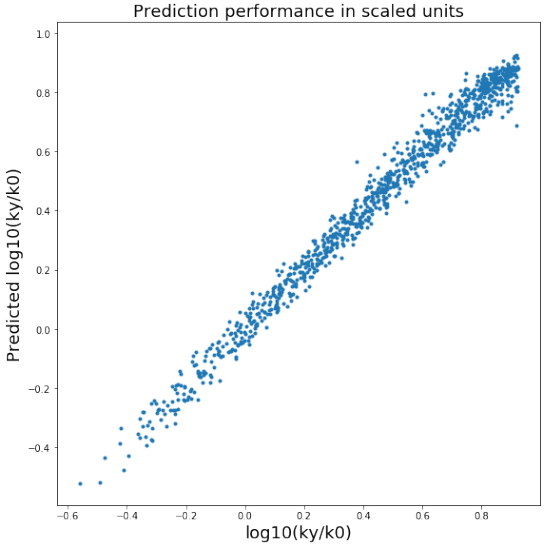
```
In [18]: ### Test the predictions of the deep learning network on some generated trajectories

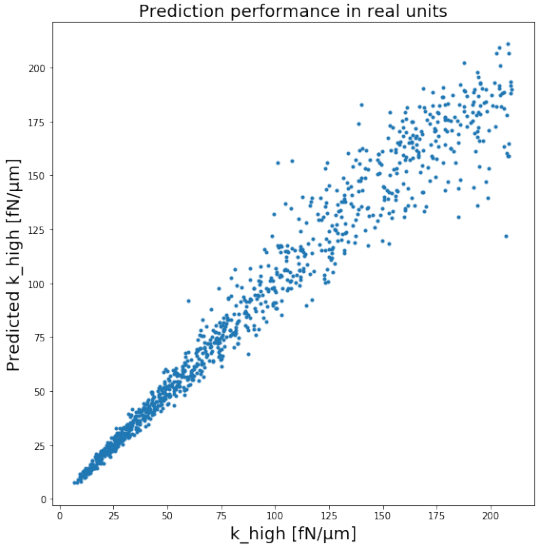
         number_of_predictions_to_show = 1000

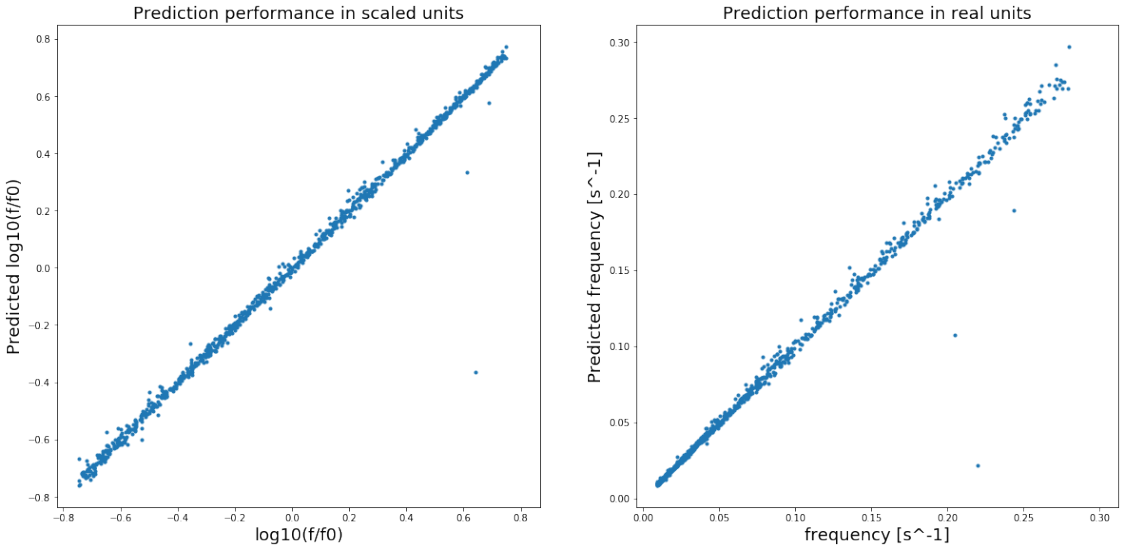
         %matplotlib inline
         DeepCalib.plot_test_performance(simulate_trajectory, network, rescale_targets, number_o
```


Prediction performance in scaled units
Predicted log10(kx/k0)
log10(kx/k0)

Prediction performance in real units
Predicted k_low [fN/µm]
k_low [fN/µm]


Prediction performance in scaled units
Predicted log10(ky/k0)
log10(ky/k0)


Prediction performance in real units
Predicted k_high [fN/µm]
k_high [fN/µm]



1.8 8. SAVE DEEP LEARNING NETWORK

Comments: 1. The parameter save_file_name is the name of the file where the deep learnign network is saved. 2. By default, the network is saved in the same folder where DeepCalib is running.

```
In [20]: save_file_name = 'Network_Example_4a.h5'
         network.save(save_file_name)
```